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ON
SPECIAL HAZARDS

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No. 6

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FOREWORD.

In offering to the public this volume on special hazards the publishers desire to express their appreciation of the efforts of the contributors who have made possible the publication of these articles for six successive years. The appreciation of the public interested in insurance is shown by the popularity of this series and its wide use as a text book to supplement actual experience in field work, both in fire and liability insurance.

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CONTENTS.

(A complete index of the five volumes in this series will be found on page 135*)*

PAGE

Crude Oil and Oil Refineries (Illustrated), by Fred C. Clarke and A. G. O'Neill 5
Gasolene, Naphtha and Benzine (Illustrated), by William J. Tallamy 14
Oil Fires, Extinguishers for, by Edward A. Barrier 29
Asphalt Plants (Illustrated), by Charles C. Dominge 31
The Insurance Engineer, by William S. Wensley 38
Motion Picture Theaters (Illustrated), by Inspectors and Engineers of Travelers Insurance Company 51
Reinforced Concrete Construction, by S. Broadhurst 70
Apple Evaporators (Illustrated), by S. H. Billinge 75
Celluloid. Its use in Shoe Factories, by E. H. Bartlett and H. P. Bruce 83
Celluloid Factory Fire 89
Breweries (Illustrated), by Charles E. Jahne 91
Cleaning and Dyeing Risks, from Circular by Iowa Inspection Bureau 97
Oxygen Tanks in Fires (Illustrated), by Russell R. Voorhees 100
Garage Fires, Prevalent causes of, by William M. Klinger... 104
Asbestos 106
Cork-wood and its Fire Hazards, by Gilbert E. Stecher 107
Combined Heating and Automatic Sprinkler Systems (Illustrated), by C. B. Mackinney 115
Lightning Rods and their Installation, from Bulletin of Ontario Department of Agriculture 121
Village and Town Fire Protection, by William S. Wensley.. 123
New York's First Water Works (Illustrated), by Charles C. Dominge 129
Fire Effect on Capstones (Illustrated) 130
Static Electricity 132
Fireproofing of Cotton Goods, by J. E. Tod 134

CRUDE OIL AND OIL REFINERIES.

Fire Hazards of the Production, Handling, Storage and Refining Described in Detail.

By Fred. C. Clarke, Oklahoma State Agent, and A. G. O'Neill, Oklahoma Special Agent, Ætna Insurance Company.

In discussing the hazards of crude oil and oil refineries, we can probably give the best picture of underwriting problems by describing briefly the processes of production, storage and refining, in the order named. We speak here of conditions as we find them in the mid-continent field, but these remarks apply also to other fields.

PRODUCTION OF CRUDE OIL.

The commonly accepted theory is that oil is found usually in "pools" under the earth's surface, and such pools are often indicated by anticlines of the earth's crust. Above the oil in such pools are usually one or more "pockets" of gas, sometimes of little consequence, and sometimes—as in a recent well drilled

POOL CONTAINING ABOUT 150,000 BARRELS.

in the Cushing, Okla., field—enough to blow out, by gas pressure alone, several hundred feet of ten-inch iron "casing," or piping.

While a gas well of great size is valuable, a large oil well is worth much more, and most operators drill through the gas sands to the oil sands or strata, letting the gas "blow" itself out. There are both National and State laws compelling oil operators to conserve the natural gas, but these laws are very poorly enforced, and the gas now going to waste each day in the Cushing and Healdton fields in Oklahoma has been estimated to be enough to turn every wheel in Oklahoma for two years.

If the driller strikes the gas above the oil, he "braden-heads" the well as soon thereafter as possible; i.e., he puts a double pipe mechanism on the casing head, which allows him to drill without interruption, while the gas blows into the air many feet above him. If gas and oil are found in the same sand, the well sprays a mist of gas and oil for perhaps two or three weeks, and may impregnate the ground with oil for 200 or 300 feet around the well. A flowing well is an oil well which has enough gas to force the oil to the surface without pumping.

Gas is always much more prevalent in new than in old fields, and, consequently, the fire hazard of new fields is always worse than that of old fields. The principal hazards in drilling wells are:

1. Lightning.
2. Carelessness.
3. Exposures.

Of the lightning hazard nothing need be said.

The carelessness hazard is composed of several elements, foremost among which are the placing of a forge in one corner of the derrick, wherewith to sharpen and repair drilling tools, and the placing of the steam boiler or open lights too close to the wells. When this is done, if the driller strikes a pocket of gas, which is practically odorless, fire ensues, burning the derrick and many of the drilling tools, and often causing horrible tragedies by burning to death the driller and his helpers. This can be remedied by carrying pocket flash lights, lighting the premises with electric arc lights and suitable reflectors far from the derrick, and by placing both the forge and the boiler 200 or 300 feet away from the derrick. These things are being done more and more in both the Cushing and Healdton fields, where we now find the worst gas hazard.

The exposure hazard, consisting mostly of uneven and hilly ground, making drainage exposure fires possible, can best be guarded against by equipping each drilling well with a steam jet, to "snuff" out any exposure or other fire, and by the construction of earthen fire ditches and "dikes" or fire walls to divert or confine the flow of burning oil.

The cost of derricks in this field is from $1,000 to $1,500 each, and the cost of "strings of drilling tools," as the complete drilling tool outfits are called, ranges from $2,400 to $4,800 each.

BURNING REFINERY TANK AT SAND SPRINGS, OKLA.

Derrick loss is usually total, and drilling tool loss usually averages about $2,000.

Another rather common lightning hazard worth mentioning consists in exposed pipes leading from wells to tanks and pump houses. One "power" or pumping plant may pump ten wells in a circle around it, and if lightning strikes the power house, and these pipes are not electrically grounded, the current may run along the pipes and ignite one or more wells or tanks.

STORAGE OF CRUDE OIL.

In every oil pool, especially in new fields, there is just so much oil, and the producer with the most wells and the largest pumping and storage capacity gets the most oil out of the pool. Hence, when a new field is opened up, every producer tries to put in storage as quickly as possible the maximum quantity of oil.

Usually the oil fields are so far from the railroads that it is impossible to build tanks fast enough to take care of production, and much oil has to be stored in "dirt storage" tanks, which are nothing but holes in the ground, roofed sometimes with corrugated iron. This is the last resort, for the oil in dirt storage loses sometimes 65 per cent. in two or three months from seepage into the ground and evaporation of the valuable volatile contents, such as gasoline, etc.

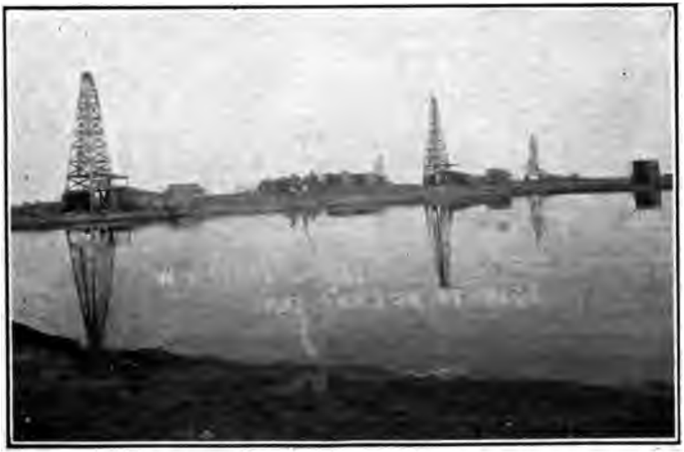
The first permanent tanks to be built are usually wooden storage tanks of 250, 500 and 1,600 barrels capacity, respectively. These tanks are usually grouped in "batteries" of four to ten each, all subject to one fire. After steel tankage is built in the field, wooden tanks are used very largely for settling tanks and temporary storage of two or three months' duration. Each battery of wooden tanks has in connection therewith one or more "flow tanks," and in these flow tanks lies a serious fire hazard. The oil from the wells flows or is pumped into these flow tanks, which have an outlet about half way from the top, so arranged that the clear oil flows from these wood or steel flow tanks, which are really settling tanks, into the wood or steel storage tanks. These flow tanks are sometimes called "gunbarrel" tanks. Each flow tank is open at the top to allow the gas in the oil to dissipate, while the "B. S." (base sediment—mostly dirt—or "bad stuff," as the oil men call it) and water in all oil settles to the bottom of the flow tank, whence it is removed at intervals by a "clean-out valve" located in the bottom of the tank. All other tanks also have this clean-out valve.

Because of the cloud of gas constantly hovering over and near these flow tanks, we believe they should be at least 75 feet away from other tanks, instead of forming one of a battery, as is more or less customary.

Steel storage tanks are built sometimes of 38,500 barrel, but usually of 55,000 barrel capacity, and are usually spaced about 400 feet apart. Each 55,000 barrel steel tank is surrounded by a dike or mound, usually about 6 feet high, supposed to hold the contents of the tank should it catch fire and boil over. However, experience of the last two years in the Cushing and Healdton fields has shown that these tanks should be at least 500 feet from dike to dike, or about 650 feet from tank to tank, as the tank sometimes behaves like a huge cannon when it is ignited and boils over, the shell spraying the burning oil several hundred feet in the air. To prevent the ignition of other tanks from this cause, one of the oil companies keeps at its headquarters a cannon mounted on a flat car. When any field telephones that a "55" is on fire, the cannon is rushed there by special train and a hole is shot through the tank, so that the oil may drain out and burn inside the dike.

LIGHTNING.

The only hazard other than the flow tank and exposure hazards is lightning. This is, of course, a providential hazard which we cannot figure, but it is undoubtedly worse in States where the humidity is high and the average wind velocity low, and better in States where the humidity is low and the average wind velocity



POOL.
SHOWING LOCATION OF DERRICKS, FLOW TANKS AND DIRT STORAGE

is high. The Gulf Coast of Texas and Louisiana and the States of Kansas and Oklahoma illustrate well these climatic differences.

A "55" usually boils over in about six hours after ignition, and this first "boil-over" ends the pumping of oil out of the tank, as the outlet is nearly always at the outside and bottom of the tank, and the heating of it makes it impossible to pump more than about 4,000 barrels of oil out of the tank in this first six hours. This boil-over usually cools off the tank somewhat, and the fire continues, another boil-over occurring in about twelve hours, and still another at about eighteen hours after the fire begins. These tanks usually burn from twenty-four to thirty-six hours. The photograph shows a full tank just an hour or two after ignition. The light portion at the top is red hot, and is just beginning to crumble in and down. This continues as the fire progresses, until the ruins usually show "Three (rims) up and three down," meaning that three rings of the steel is crumpled while three remain standing. There is practically no salvage in the burned tank shell, the fire often being so hot that it burns quarter-inch plates at the top entirely out of existence.

It seems strange that companies writing steel and wood storage tanks in the mid-continent field should compete with each other so vigorously for this very hazardous business that the oil men are not forced to keep their equipment in standard condition, as do the larger operators of their own volition. Several of the larger operators have installed steam jets in their steel tanks, and when an electrical storm is imminent, live steam is turned into each tank. The cost of equipping each tank with four steam jets totals about $400, but the good fire record on tanks so equipped would seem to warrant this expenditure, as each "55" costs from $10,000 to $14,000, depending on drayage, cost of foundation, excavation, etc., and the oil therein is worth from $27,500 to $75,000, depending on quality and market price.

We believe that by keeping an empty concrete or brick gravity reservoir for each five "55's" in every field, and by placing in the center of each tank a 12-inch gravity drain controlled by a gate valve outside the dike, with drain pipes buried under the tank and under the ground inside the dike, salvage on contents of full "55" in case of fire should be easily 45,000 to 50,000 barrels of oil, and one such fire with such salvage would more than offset the cost of this equipment, which would be about $1,800 per tank.

There are now on the market several automatic devices for extinguishing fire in oil tanks, the best we know of being that of the Erwin Co., Milwaukee, Wis., which costs about $1,200 per tank. Some of these devices work well experimentally, when the tank is ignited by human agency, but we do not know what

"BULL HEAD NO. 3" IN THE HEALDON FIELD BURNING.

would happen when countless millions of volts of electricity should strike a tank so equipped. Personally, we would rather put our trust in gravity salvage than fire extinguishers. However, the acid test of experience will in time prove the worth of these devices.

REFINERY HAZARDS.

Without going into technical details, we may say that the refining process consists essentially of the heating of the crude oil in steam and fire stills, the clarifying of the product of these stills in "agitators" (large tower tanks wherein the product is agitated or mixed with sulphuric acid, to remove the asphaltine content of the oil), the "washing" or clearing of the product of sulphuric acid residue, and subsequent storage and shipment of product, which may be gasoline, kerosene, benzine, lubricating oil, etc., etc. In certain fields producing oil with a paraffine base, such as the Pennsylvania and the Muskogee, Oklahoma, fields, the refineries also manufacture paraffine wax, using camels' hair press cloth, power presses, and processes somewhat similar to cotton and linseed oil mill oil extraction.

Nearly all refineries, leaving out the "skimming stations," are large bonded corporations of great financial strength, absolute honesty and excellent business ability. They are also consistent insurers, and keep the fire hazard of their plants down to the minimum. In fact, our experience with and investigations into refinery fires develops the belief that practically all refinery fires originate from lightning striking either the "crude group" or the "refinery group" of oil tanks on the refinery tank farm. The crude group receives the oil as it is pumped from the fields and producers' storage tanks, and the crude oil is then pumped from the crude group to the refinery group as it is needed from time to time. This causes a very bad gas hazard in both these groups, as tanks are constantly being filled, emptied or oil mixed therein, and each time crude oil is agitated it gives off more or less volatile inflammable vapors, which are usually heavier than air, and hover over the tank on a still day—seemingly a magnet for a stray bolt of lightning.

The refineries proper constitute a good physical and moral hazard, if we except the storage tanks in connection therewith, and only the physical hazard of these is bad.

The enormous values in the oil industry in the mid-continent field, the excellent moral hazard of nearly all classes of oil property, and the constant improvement of the physical hazard make it seem probable that more and more companies will write at least some classes of oil insurance. We believe that this can be done at a profit, especially if the companies interested will incorporate into their policies reasonable standards of equipment and maintenance, as shown by past experience and present observation of the many peculiar conditions connected with the oil business.

From all indications and geological reports, the oil industry in the mid-continent and certain other fields will very probably flourish for the next thirty or forty years, and the companies writing oil business will in that time reap an enormous harvest of premiums—and possibly of losses if Dame Fortune frowns, but smiles not.

The several photographs accompanying this article, showing dirt storage pools, derricks, wood and steel storage tanks, burning tanks, etc., are all from the Tulsa and Healdton fields. Many of these fires we saw personally, and they were beautiful, though costly, spectacles. The Twin State Oil Co. tank fire and three other tanks burning at the same time in the Healdton fields we saw quite plainly from Sulphur, Okla., at night, sixty miles away as the crow flies. We were also in the midst of a very severe lightning storm in the Cushing fields and with the weird background of black thunderclouds, driving rain and cannon cracks of lightning, the majesty of a large oil fire truly beggars description.

In conclusion, we may say that lightning is the one serious and absolutely uncontrollable hazard menacing the companies writing oil business, and, like the Kansas tornado, it is "liable to happen 'round 'most any old time." However, we believe that the experience of several companies over a period of years will provide at least a fair "mortality table" on the class, so that companies writing same may reasonably expect and make a profit on their courage and underwriting judgment.

GASOLINE, NAPHTHA AND BENZINE.

A Brief Reference to Their Origin, Nature and Process of Manufacture; Common Uses and Dangers; Approved Methods of Storing and Handling.

By William J. Tallamy, Inspector.

The enormous and fast increasing use of these exceedingly dangerous liquids vitalize their importance to fire and insurance engineers and underwriters.

Briefly stated, they are hydrocarbons, the lightest distillates of petroleum of commercial importance. Crude petroleum is a natural product found in many parts of the world, notably in America, Europe, Russia and India. It is a conglomerate mixture of a number of inflammable constituents and probably owes its origin to the gradual decomposition of vegetable or animal matter under subterranean heat and pressure. It issues from an underground strata formation which is usually tapped, the crude oil being forced to the surface under its own pressure or is withdrawn by ordinary oil pumps.

In its crude state petroleum varies in color from a faint yellow to a dirty brown. As it is taken from the wells it is shipped, occasionally in barrels or tank cars, but more often pumped direct through iron pipe lines to the oil refinery, where it is separated into various fractions of high individual commercial value. This is easily accomplished by a process of distillation which, owing to the fact that each of the fractions enter into the formation of crude petroleum has a distinctly different boiling point.

On reaching the refinery and prior to entering the stills, crude oil is allowed to settle in large storage or settling tanks a certain length of time, where some of its impurities, such as dirt, water, etc., collect at the bottom or top and are removed.

Oil refineries differ in equipment detail according to their product, but usually their processes are similar and more or less continuous.

While it is possible to produce nearly all of the lighter petroleum distillates of commercial value at one distillation, modern refineries usually employ several stills; the first or crude oil still dividing the oil into three or more general fractions, most of which are subsequently separated into final fractions by further distillation.

The method of separating the various fractions as they are produced is very simple and practically continuous. The vapor as it passes off from the still is conducted in pipes to condensing coils similar in action and principle to those commonly found in refrigeration plants, the coils containing the vapor being immersed in or otherwise cooled by running water. As the vapor is suddenly chilled by the action of cool water on the outer surface of the pipe, it condenses and liquifies. The liquid thus formed passes on through pipes leading to the weighing instruments, which are under constant supervision of a competent employee whose duty is to see that the various distillates are separated according to their specific gravity and run into proper receptacles, from which they are taken as desired for further distillation, or to be chemically or otherwise treated for refining purposes.

As a rule the first distillates given off by the crude oil still, consisting of cymogene, with a boiling point of 32 degrees F.; Rhigolene, boiling at about 60 degrees F., and petroleum ether, boiling at 100 degrees to 150 degrees F., are seldom taken separately, but are usually run collectively into the same receptacle and sold as petroleum ether without further distillation. Occasionally this product is also disposed of as high grade gasoline, or run into the receptacle with the ordinary gasoline.

Ordinary or commercial gasoline, however, is usually taken from the second fraction given off by the crude oil still, as are also naphtha and benzine. This fraction is produced when the temperature in the still is approximately between 150 degrees and 300 degrees F.

Crude oil stills are usually heated by direct fire, coal and coke being used as fuel. Steam-shovel stills are frequently used in redistilling and refining.

NATURE.

Ordinary gasoline, benzine and naphtha are by far the most common of the dangerous petroleum distillates in general use. They are highly inflammable, colorless liquids, differing slightly in their flash, burning and boiling points and specific gravities.

All of these tests are subject to more or less fluctuation due to the varying nature and origin of the crude petroleum from which the distillates are taken and the different methods of distilling, weighing, separating and refining, as employed by the various oil refineries.

Gasoline, the lightest of the three, has a specific gravity of .64 to .66, boiling at 150 degrees to 194 degrees F. Naphtha has a specific gravity of .69 to .72 and boils at 176 degrees to 230 degrees F. Benzine, the heaviest of the three, has a specific gravity of .72 to .75 and boils at 225 degrees to 302 degrees F.

There seems to be more or less confusion in the minds of the general public regarding the distinction between the flash and burning points of inflammable liquids. The flash point of a liquid is the temperature at which it will evolve vapor in sufficient quantity to ignite in the form of a flash at the introduction of a spark or flame, but insufficient to cause it to burn continuously or to set fire to the liquid.

The burning point is the temperature at which the vapor given off is dense enough to burn continuously, causing the fire to spread to and ignite the liquid itself.

There is a wide difference between the flash and burning points of petroleum products, especially benzine, gasoline and naphtha.

As the boiling points of the light petroleum distillates vary, so also do their flash points; the temperature of the latter depending largely upon that of the former.

The flash point of gasoline, naphtha and benzine will change if they are exposed to air at and below ordinary temperatures, as vapors will constantly be passing off from them, the flash point rising in consequence.

This is due to the fact that the lowest flashing constituent evaporates first, the flash test rising as evaporation proceeds.

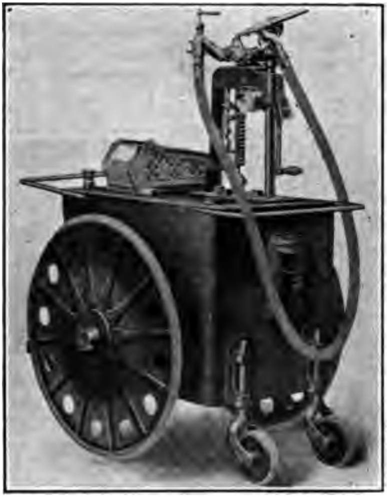


FIG. 1. PORTABLE GASOLINE TANK.

Owing to their varying natures it is practically impossible to name any one temperature as the lowest at which they will flash, as that depends entirely upon their quality; the flash test of each being fed by the vapor of its lightest constituent.

For example, gasoline may contain a small percentage of petroleum ether, in which case the flash test will be the temperature at which petroleum ether will produce ignitable vapor, which is considerable, probably 40 degrees to 50 degrees below zero F.

Ordinary gasoline will usually flash below zero F. If its boiling point is 150 degrees F., its flash test will be between 30 degrees and 40 degrees below zero F. If the boiling point of gasoline is 176 degrees F., which is probably more often the case, it will flash at about 7 degrees below zero F.

The average naphtha in common use will probably flash at about zero F.; benzine produced at 225 degrees F. will flash at about 60 degrees F.

The vapor of all three will ignite and burn at or below ordinary temperature, the burning point of gasoline being about 60 degrees F. under ordinary conditions.

They are exceedingly dangerous liquids at and above temperatures at which they will flash, though their dangers increase as the temperature rises. Below their burning tests the danger of explosion is more imminent than that of fire; though the heat from explosion usually raises the temperature to or above the burning point, and fire results.

Benzine, naphtha and gasoline will not mix with water, and having no affinity for oxygen they are not subject to spontaneous ignition.

Unlike water they are non-conductors of electricity and have been known to generate sufficient frictional electricity when being strained through a fabric strainer or run through a rubber hose to cause an electric spark and thus ignite their own inflammable vapors.

Under atmospheric pressure they readily vaporize at ordinary temperature, gasoline vaporizing at about 60 degrees F. Vapor thus formed is of a highly inflammable nature and very explosive when properly mixed with air; the explosive range being 5 to 20 per cent.

It is estimated that 5 gallons of gasoline will generate 8,000 feet of gas, which, if ignited when confined, will expand with tremendous force. The explosive force of the vapor of one gallon of gasoline, under favorable conditions, is said to be equal to about 83 pounds of dynamite.

The vapor from one pint of gasoline will impregnate to an explosive degree 200 cubic feet of air.

This vapor is much heavier than air and when liberated promptly settles to the floor with a stratifying tendency. It has frequently been known to travel in an invisible cloudlike stream near the floor of a room and ignite by contact with an open flame, spark or stove some distance from the point of vapor emission; the upper part of the room at the same time being comparatively free from vapor at points much nearer its source. Under these conditions the vapor is consumed by a lightning-like flash which carries the flame from the point of ignition to the receptacle containing the gasoline or similar inflammable liquid, setting fire to same and any inflammable material in contact with the flash.

In view of these facts one can hardly overestimate the severity of hazard concomitant with the careless handling or use of any of these volatiles.

USES.

To enumerate and define in detail all of the many uses made of gasoline, naphtha and benzine would occupy a lengthy treatise in itself; therefore only a brief reference to some of their general and specific uses will be made here.

It is a notable fact that there are comparatively few manufacturing establishments at the present time in which at least one of them is not used to a greater or less extent.

In oil, paint, varnish, rubber, japan and similar factories they are freely used as thinners and solvents. Gasoline is probably more commonly used as a motive power in running automobiles, motor boats, aeroplanes, machinery, etc. In rural districts its use is more general, being frequently employed in running lumbering and farming machinery and for illuminating, cooling and heating purposes.

Naphtha is commonly used as a turpentine substitute in paint and varnish works and as a thinner and drier for paints, varnishes and japans in factories where painting and varnishing are done to any great extent, involving the dip tank, air brush, dry room and other similar and severe hazards.

Benzine is the dangerous element usually met with in benzine or so-called dry cleaning and dyeing establishments, where it is frequently and often carelessly kept and handled in large quantities. It is a common practice to have large amounts of benzine in open vessels in the working parts of such establishments. There fabrics are dyed by being dipped in open vats, tubs or large cans containing dye colors dissolved in benzine; probably 98 per cent. of the solution being benzine.

After the fabric has been immersed in the dyeing solution a sufficient length of time the surplus liquid is removed by an ordinary hand power wringer or by the use of a power centrifugal extracting machine. Further and final drying is done by evaporation, which is safest when the fabrics are hung on lines or racks in the open air. Some establishments do their drying in heated dry rooms, which is exceedingly dangerous and often leads to disastrous results. Such dry rooms should always be in detached fireproof buildings, well ventilated by openings at sides near the floor an dceiling. If impossible to have dry rooms in detached buildings they should at least be fireproof and properly ventilated to outside of building.

Open lights and direct heat in such dry rooms are prohibitive. Incandescent electric lights with keyless porcelain sockets and properly installed steam heat are permissible when rooms are well ventilated.

The processes and hazards in benzine cleaning establishments are similar to those of dry dyeing establishments. The fabric is immersed in a bath of benzine, either in an open vat or tub, or in an ordinary revolving or alternating power washing machine. The method of drying the fabric after cleaning is practically the same as that employed in dry dyeing establishments.

BENZINE RECLAIMING

Benzine reclaiming is frequently done in dry dyeing and cleaning establishments. The process is simple. Discolored benzine is placed or run into covered and sometimes open vats or tanks, where it is allowed to settle until the dirt collects at the bottom. The clean benzine is then removed and run into storage tanks for further use. In some establishments the dirty benzine is filtered through cheese cloth or similar fabric strainer on which the dirt is deposited. Here there is danger of sparks resulting from static electricity, which have been known to set fire to the vapor given off by the benzine. This phenomenon is caused by the frictional contact of two non-conductors of electricity. Benzine being a non-conductor in passing through the fabric also a non-conductor generates a certain amount of electricity. If this electricity finds its way to a conductor such as a metal funnel or can, which may perhaps be receiving the benzine, said conductor will become charged with sufficient electricity to cause a spark should another conductor be placed near enough to permit the electric current to pass or shunt from one to the other. This will be possible only when the two conductors are close together but not in contact; the spark or arc being caused by the current in shunting from one to the other.

The conditions necessary to cause such a phenomenon as this are likely to occur in any plant where benzine or gasoline filtering is done in this manner;therefore too much emphasis cannot be placed on objections to such practice.

The use of gasoline, benzine and naphtha has become very common and their hazards are generally fairly well known. At the same time the fact that no accidents occur with reasonable care, has a tendency to promote and develop carelessness, which is likely to be followed by disaster.

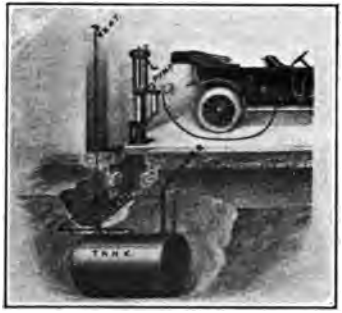


FIG. 2. THE PUMP OR BOWSER SYSTEM.

Owing to their great commercial advantage their further use will probably increase rather than diminish. It is therefore necessary for fire and insurance engineers and inspectors to see that they are stored, handled and used under such restrictions as will eliminate unnecessary dangers.

To this end various municipal and underwriting agencies throughout the country have caused to be enacted such laws as will in a large measure control the dangers attending the storage and handling of inflammable liquids; but it is not to be expected that all dangers will be eliminated by the compliance with these laws, as they practically control the method of storage and handling only and have little effect upon the subsequent uses, which must be watched by the inspectors. It is a deplorable fact that most consumers feel that in complying with legal requirements their duties are complete, little thinking that in permitting subsequent abuses that are beyond the letter of the law they practically defeat its object.

APPROVED METHODS OF STORING AND HANDLING.

Approved methods of storing and handling inflammable liquids as adopted by the various municipalities differ in detail; but generally speaking in principle they are practically the same. The majority of cities and towns in the United States now prohibit the storage and handling of gasoline, naphtha and benzine, except in very small amounts, without special permit under which it is agreed that same shall be kept and handled in a manner approved by officials in charge of such matters in each respective municipality.

The practice of keeping reserve supplies of such liquids in cans or tanks inside of buildings occupied for other purposes is dangerous and should be discouraged. In such cases as may be necessary, approved metal safety cans limited in capacity to one days' supply should always be provided for amounts kept on hand. All in excess of one quart should be kept in safety cans outside of buildings, in fireproof vault or metal lined box, when not in actual use. In garages, portable approved 50-gallon safety tanks (Fig. 1) may be permitted when it is not practicable to fill car tanks direct from discharge pipes of pumps or other apparatus used in withdrawing inflammable liquids from storage tanks, as will be described later on. Where portable tanks are used, the liquid should be withdrawn by automatic measuring pumps and discharged through hose, as described in detail under the Bowser storage system.

At the present time there are three popular and approved methods or systems used in the storage of dangerous volatiles, namely: the pump or Bowser system; the Snell or hydraulic system and the Martini and Hüneke system. A cylindrical shaped steel or wrought iron underground tank is used as the container in each of these systems. The tanks vary in detail according to the systems and the amount of liquid to be stored. All such tanks however should meet with the following requirements:

The walls of all tanks shall be constructed of steel or wrought iron plates having a minimum thickness of No. 14-gauge U. S. standard, except when pressure, other than gravity, is used in withdrawing the liquid, as in the Martini and Hüneke system, when the minimum thickness of wall plates shall be ¼ inch.

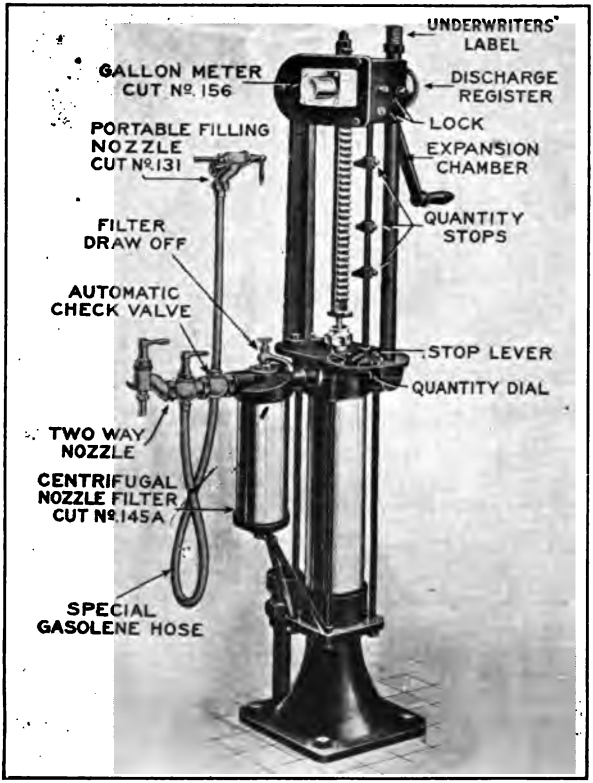


FIG. 3. THE BOWSER LONG-DISTANCE SELF-MEASURING PUMP.

Plates shall be riveted, welded or brazed together and if to be used with a pressure discharge system, shall safely sustain a hydrostatic test at least double the pressure to which tank may be subjected in use. Top of tank to be securely fastened to top ring with joints of equal tightness to those between rings. They shall be covered with asphaltum or non-rusting paint or coating. All pipe connections shall be made through flanges or reinforced metal securely riveted, welded or bolted, to the tank and made thoroughly tight.

All storage tanks shall invariably be firmly set on a rich concrete foundation or footing course, the sides and top of same to be enclosed by 12 inches of rich concrete. The tank shall be buried so that its highest point will be at least 2 feet below the ground; and if tank is within 10 feet of any building its top shall be at least 2 feet below cellar floor of said building.

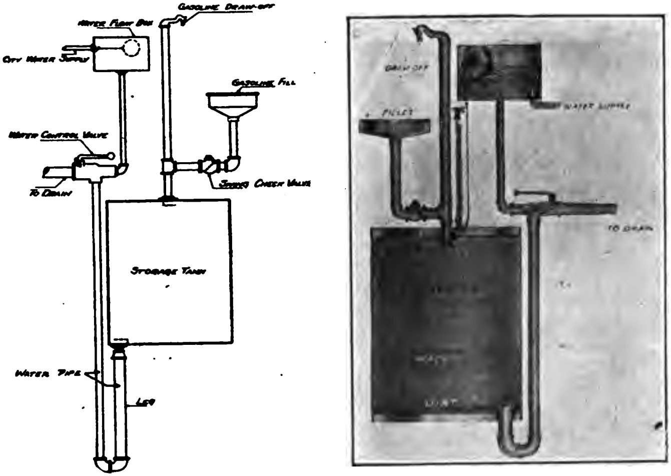


Fig. 4. Showing the Hydraulic Storage System in Two Forms.

PUMP OR BOWSER SYSTEM

The most popular system is the pump or Bowser system, so called because it was first invented and placed on the market by S. F. Bowser of S. F. Bowser & Co., Fort Wayne, Ind., some thirty years ago. There are now many different concerns installing similar systems under their own respective trade names.

In this system the inflammable liquid is stored under atmospheric pressure and withdrawn as desired by an automatic measuring hand-power oil pump.

As air charged with explosive vapor is always more or less present in the storage tanks of this system, said tanks must be properly ventilated by a galvanized iron pipe not less than 1 inch in diameter and shall run from the top of tank to at least 10 feet above the roof of the highest building within 10 feet of pipe. Vent pipe shall be capped with a double gooseneck or cowl fitting provided with a fine brass wire screen just inside of each opening to prevent foreign substances from entering and clogging same.

In addition to vent pipe these tanks must be provided with an intake or filling pipe and a draw-off pipe, both of which shall incline toward tank. There are numerous approved hand pumps in use at the present time, most of which measure automatically. They are so constructed that the amount of discharge is accurately controlled by the length of the pump stroke.

The pump (see Fig. 3) is equipped with a cylindrical tank usually of sufficient capacity to supply one full stroke. As this tank or part thereof is emptied by a full or partial stroke, the liquid removed is automatically replaced from the storage tank by the same stroke. In other words, if the maximum measuring capacity of such a pump is one gallon the cylindrical tank will hold one gallon, all of which is removed and replaced by one full stroke of pump. If only one quart is desired it can be withdrawn by setting a lever or check on the pump, which stops the pump after one-quarter of its stroke has been taken, one-half of full stroke discharging 2 quarts, three-quarters discharging 3 quarts, etc.

Pumps should invariably be located above grade when inside of any building, preferably on ground floor near entrance. When possible and practicable the gasoline or other inflammable liquid should be discharged directly from the pump into its final receptacle without the use of cans.

All pumps, and in fact the withdrawing apparatus in all storage systems, should be provided with a strong non-static rubber hose having a shut-off valve at its nozzle. The oil should always be discharged through said hose, which should not exceed 16 feet in length. With the use of this hose the liquid can be discharged directly into the tanks of automobiles or other receptacles, thereby preventing unnecessary drip, splashing or leakage.

THE HYDRAULIC SYSTEM

The Hydraulic system (see Fig. 4) is also popular but obviously more modern than the so-called pump or Bowser system. It was invented by Luther C. Snell about 14 years ago, but was not sufficiently approved to be placed on the market for general use until about 6 years ago. The radical difference between the hydraulic and Bowser systems is in the manner of withdrawing the liquid. The hydraulic system requires no pump, the liquid being withdrawn as needed by light water pressure.

The hydraulic system is so extremely simple that it needs but a few words of explanation to enable anyone to understand the principles of its operation. Water is heavier than gasoline, benzine or naphtha and will not mix with them. If water and any of these liquids be stored in a tank together the water will always be at the bottom and the petroleum distillate at the top with a sharply defined line between the two liquids. If one pipe is run from the top of the tank and another into the bottom, and the latter pipe be permitted to convey water into the tank, then the petroleum distillate will flow out of the top pipe as readily as water flows into the tank through the bottom pipe and will be lifted to any height which has been previously determined by the location of a float box which controls the water level. In this manner gasoline or similar liquid is carried to such height as may be desired. It is easy to prevent water from reaching the discharge pipe by properly regulating the water level.

The storage tank of the hydraulic system does not require a vent pipe, inasmuch as the tank is always full of liquid while in use; there being no air space, it is not possible for explosive vapors to collect in the tank. Essentially the equipment of the hydraulic system consists of an underground storage tank, a waterfloat box tank similar in action and principle to an ordinary water-float box tank as commonly used in flushing closets, a filling and a draw-off pipe. The water-float box is connected by galvanized iron pipe to the bottom of storage tank. About midway between the two is a direct sewer pipe connection. The float box is supplied by water through a direct connection to a city water main or other similar source of constant water supply. The office of the water-float box is to provide a proper water head. It is therefore located at such elevation as will furnish water pressure sufficient to force all of the inflammable liquid out of the storage tank through the draw-off pipe, but insufficient to force any of the water out through the same pipe. The water in the float box and the direct sewer connection are under control of a double-acting lever hand valve located in the pipe line between the float box and storage tank at the junction of the direct sewer connection. This valve has two seats, and is so constructed that when the seat controlling the flow of water from the float box is closed the other seat, which controls the sewer connection, is open.

In action when the lever valve is raised water flows down from the float box and enters the storage tank at the bottom, forcing the oil out through the draw-off pipe which enters tank at the top. When sufficient oil has been withdrawn, the lever is lowered, which promptly stops further water from entering the storage tank from the float box, at the same time opening the sewer outlet which allows the gasoline still in the draw-off pipe to gravitate back to the storage tank; the gasoline head being sufficient to force enough water out of the storage tanks through the sewer connection to permit the return of the gasoline.

A check valve in the filling or intake pipe prevents the liquid in the storage tank from being forced out through this pipe.

THE MARTINI AND HÜNEKE SYSTEM.

The Martini and Hüneke system (see Fig. 5), a product of Germany, was invented by Carl Martini about 10 years ago. This system has been in general use in European countries, Germany in particular, about 9 years, but owning to its comparatively recent introduction it has not as yet met with universal approval in this country. It has, however, been approved for use by the United States navy department and the bureau of combustibles of the city of New York fire department, and is now said to be undergoing minor changes which are expected to meet the requirements and gain the approval of the Underwriter's Laboratory of Chicago. The Martini and Hüneke system is in a sense more complicated than the other systems, though simple in action and having other merits of importance. Unlike the other systems, previously referred to, the inflammable liquids stored by this method are constantly under more or less working pressure ranging from 5 to 50 pounds under proper working conditions.

This pressure is produced and maintained by an inert gas, usually carbon dioxide in small plants and a mixture of about 88 per cent. nitrogen and 12 per cent. carbon dioxide in large plants. Here the gas takes the place of the air or water, as found in other systems, and as the gases used will not support combustion, their presence adds to the safety of this system.

PRINCIPLE

The principle of the Martini and Hüneke apparatus is shown in Fig. 5. It consists of a storage tank (1) of heavy sheet metal buried in the ground, inlet and outlet pipes and valves, a cylinder of compressed inert gas for protecting the liquid and forcing it through the piping system, and jacketed pipes connecting the different parts of the system. Details as to construction and location are as previously described. The anti-diffusers (2, 3, 4 and 5) attached to the end of each pipe in the storage tank operate on the well known principle of the Davy safety lamp. The upper part being filled with wire gauze admits of the passage of either liquid or gas, at the same time preventing the passing of a flame into the storage tank. The cupped bottom of the anti-diffuser is kept constantly filled with a small quantity of the stored liquid forming a seal and thus preventing diffusion of the gas in the storage tank after the pressure has been reduced to that of the atmosphere.

Pipes, valves and fittings (6, 7, 8, 13 and 14) used to conduct and control inflammable liquids and inert gas through this system, are made of lead and tested at about 350 pounds pressure. They are jacketed or double; the inner tube being used by the liquid and the annular space between the tube and the outer shell by the inert gas under pressure.

The carbon dioxide cylinder (9) is an ordinary steel cylinder similar to those commonly used by dealers throughout the country in supplying this gas. The pressure of the gas in this cylinder when delivered is usually about 700 pounds. As 15 pounds pressure is sufficient to operate the average system, a radical reduction is necessary before the gas is allowed to enter the storage tank. This is done by an automatic pressure reducing valve (11), a needle valve, located in the high pressure gas pipe line (10) through which the gas passes, its pressure being reduced as desired, usually to 10 or 15 pounds and seldom over 50 pounds.

After leaving the reducer, the gas pressure is regulated and controlled by a mercury manometer (15) designed to prevent any excess of pressure from entering the storage tank should an accident occur or the pressure reducer fail to work properly. Any excess pressure being expelled through the manometer.

The independent gas pipes (10 and 12) are made of copper and said to be tested at about 750 pounds pressure. They are ¼ to ½ inch in diameter according to the size of the equipment.

OPERATION.

To charge the storage tank it is first filled with inert gas, then connected to the drum of inflammable liquid by means of a jacketed pipe and syphon. The pipe is provided with two valves, through one of which the liquid is syphoned into the storage tank, while the other permits gas from the storage tank to replace the liquid in the drum as fast as it runs out. The syphon is induced by a light pressure of gas from the storage tank.

The pressure of the gas in the storage tank determines the height to which the liquid rises in the piping system, while the annular jacket space surrounding the distributing pipes is always in communication with the inert gas of the storage tank and assures an instantaneous return of all the liquid contained in the piping in case of a leak in any part of the system. If a leak is sprung in the inner piping the pressure is equalized and in case the outer pipe is ruptured the pressure drops to that of

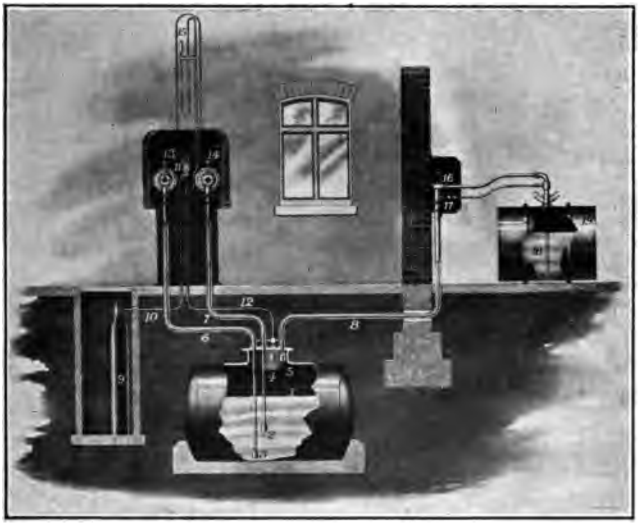


Fig. 5. A Typical Martini & Hüneke Garage Installation.

1. Storage Tank.
2. Anti-Diffuser.
3. Anti-Diffuser.
4. Anti-Diffuser.
5. Anti-Diffuser.
6. Jacketed Pipe Connection to Draw-off Valve.
7. Jacketed Pipe Connection to Draw-off Valve.
8. Jacketed Intake Pipe.
9. Carbon Dioxide Cylinder.
10. High Pressure Gas Line to Pressure Regulator.
11. Pressure Regulator.
12. Low Pressure Gas Line to Storage Tank.
13. Jacketed Draw-off Valve.
14. Jacketed Draw-off Valve.
15. Mercury Manometer.
16. Liquid Intake Valve.
17. Gas Valve for Equalizing Pressure.
18. Syphon for Emptying Drum.
19. Shipping Drum for Inflammable Liquid.

the atmosphere. In either case the liquid in the distributing system returns to the storage tank by gravity. For a further protection each pipe which enters the storage tank passes through an anti-diffuser. This device serves as a safety valve to prevent the inert gas from leaving the storage tank and becoming replaced by air in case the piping system is destroyed by fire or otherwise. All the outer pipes of the system are provided with fusible plugs which melt at a low temperature and thus assure the automatic return of all inflammable liquid to the storage tank in case of fire.

To draw the liquid from the storage tank it is only necessary to press the lever of the discharge valve. The liquid immediately rises through the jacketed pipe, owing to the inert gas pressure in the storage tank and continues to flow through the valve until the pressure on the lever is released.

The dangers met with in the storage of inflammable liquids in reasonable amounts are largely overcome with the use of any of these systems. The important question therefore is: Are the hazards as carefully guarded after dangerous liquids are withdrawn from the storage system for use? In a great majority of cases it is safe to say that they are not.

As it is not within the bounds of practicability to frame general rules and regulations that will properly cover these hazards in all classes of risks, the major share of responsibility for their curtailment or elimination lies with the inspectors directly interested in fire prevention, who are practically the only ones in possible touch with subsequent conditions.

Inspection departments should therefore be liberal in time and effort when such hazards as these are involved, being ever mindful of the fact that undue carelessness in the use or handling of any of these dangerous liquids is more than likely to result in ultimate disaster.

EXTINGUISHERS FOR OIL FIRES.

Efficiency of Sawdust as a Fire Extinguisher. Other Suggestions and Experiments.

From Address by Edward A. Barrier.

The only principles that can be made use of in extinguishing fires in volatile oils are to form a blanket either of gas or of solid material over the burning liquid which will exclude the oxygen of the air, or to dilute the burning liquid with a non-inflammable extinguishing agent which is mixable with it.

To the blanketing type of extinguishers belongs sawdust. Paradoxical as it may seem, ordinary sawdust is an excellent extinguishing agent for certain volatile liquids, especially those of a viscous nature. A considerable number of experiments were conducted in the fall of 1912 by the inspection department of the Associated Factory Mutual Fire Insurance Companies in the extinguishing of fires in lacquer and gasoline in tanks with sawdust, and the results were surprisingly satisfactory.

The efficiency of the sawdust is undoubtedly due to its blanketing action in floating for a time upon the surface of the liquid and excluding the oxygen of the air. Its efficiency is greater on viscous liquids than on thin liquids, since it floats more readily on the former than on the latter. The sawdust itself is not easily ignited, and when it does become ignited it burns without flame. The burning embers have not a sufficiently high temperature to reignite the liquid.

The character of the sawdust, whether from soft wood or hard wood, appears to be of little or no importance, and the amount of moisture contained in it is apparently not a factor, so that the drying out of sawdust when kept in manufacturing establishments for a time would not affect the efficiency.

It was found that the admixture of sodium bicarbonate greatly increased the efficiency of the sawdust as shown both by the shortened time and the decreased amount of material necessary to extinguish the fires. A further advantage of the addition of bicarbonate of soda is that it decreases the possible danger resulting from the presence of sawdust in manufacturing plants, since it would be difficult, if not impossible, to ignite the mixture by a carelessly thrown match or any other ready source of ignition.

Although the efficiency of the sawdust is greatest on viscous liquids, such as lacquers, heavy oils, japan, waxes, etc., in the tests referred to. fires were extinguished in gasoline contained in the smallest tanks and also when spread upon the ground. In larger tanks the sawdust or bicarbonate mixture does not work so well since the sawdust sinks before the whole surface can be covered, whereupon the exposed liquid reignites.

In recent years carbon tetrachlorid has received considerable attention as a fire-extinguishing agent. This is due largely to the activity of certain manufacturers of fire-extinguishers which use liquids, the basis of which is carbon tetrachlorid.

This substance is a water-white liquid, and possesses, when pure, a rather agreeable odor, somewhat similar to chloroform. It is non-inflammable, non-explosive, and is readily mixable with oils, waxes, japan etc. When mixed with inflammable liquids it renders them non-inflammable, provided a sufficient quantity is added. Its vapor is heavy, the specific gravity being about five and one-half times that of air, consequently it settles very rapidly. As an extinguishing agent it dilutes the inflammable liquid and it forms a blanket of gas or vapor over the burning liquid, which excludes the oxygen of the air.

ASPHALT PLANTS.

Character of Asphalt—Methods of Procuring and Preparing—Uses—Fire Hazards Pointed Out.

By Charles C. Dominge, Insurance Engineer-Underwriter, New York City.

At Vandalia, Ill., on March 11, 1913, a modern Paul Revere distinguished himself by riding at breakneck speed down a steep hill, warning the villagers below of their imminent peril from a stream of burning asphalt. A tank of asphalt roofing compound had been exploded by the heat from a burning rag warehouse located nearby, and the burning mixture, flowing on the water in the ditches, brought destruction to buildings fully a thousand feet away.

HISTORICAL.

The Bible tells us that the basket in which Moses was left in the bulrushes was "pitched without," and no doubt it was asphalt, as the first known deposit of asphalt was found in Egypt. Later on, and through centuries the ancients used the same pitch for covering their embalmed dead and many mummies have been found in recent years and are still being found, where the asphalt coating is distinguishable. There is an authentic case on record of the discovery of a hull of an ancient shipwrecked vessel that had lain on the bottom of the sea for ages, and on inspection showed that its bottom was coated with asphalt, which remained in a fair state of preservation in places where it was buried deep in the sand and thus protected it from the abrasion of the washing sand.

WHAT ASPHALT IS.

Asphalt is the name given to a bituminous substance of solid consistence. It is known under many names, such as Native Pitch, Mineral Pitch, Jews Pitch, Dead Sea Bitumen, Compact Bitumen and Maltha.

It probably owes its origin to vegetable matter which has been subjected to a slow process of decomposition or decay, resulting in the production of a bituminous coal, from which, by volcanic agency, the asphalt has been distilled and diffused over the neighboring district.

Some people believe that nature in the formative period of the earth made these asphalt deposits by the fiery destruction of both vegetable and mineral oils. The non-combustible bitumen of the burned oil flowed into the crevices of the earth, from whence we now extract it..

Asphalt is also taken from the earth in a liquid state by pumping to the surface from holes called wells. This product seeks the lower level because of its liquid state. It is said to contain between 5 and 30 per cent. of naphtha and it is therefore more dangerous than ordinary asphalt.

WHERE ASPHALT IS FOUND.

The largest deposit of asphalt in the world is located at Pitch Lake on the Island of Trinidad, where it fills a basin to a depth of nearly 100 feet. Other deposits are found at San Timolis, Venezuela; Mexico, Santa Barbara County, California; Central Kentucky, Seyssel, France; Val de Travers, Switzerland; and Ragusa, Italy. Recent reports show that asphalt in a practically pure state has been discovered in large quantities on the Island of Leyte in the Philippines and this product bids fair to become an important natural product of the island, says the Manila *Daily Bulletin.*

VARIOUS USES OF ASPHALT.

Asphalt has many uses, the product from Trinidad is largely used for ships' bottoms, and is reputed to kill the teredo or borer, which proves itself so very destructive to the wood of ships in Tropical regions. It is also used for paving purposes, roofing compounds, painting (thinned with petroleum distillates), and the material recently found in the Philippines is said to be suitable for the finest uses, such as Japanese lacquer work, etc. Asphalt in a heated condition is used for saturating timber which is intended for piles to be used in the construction of breakwaters, river-bridges, and other situations where the combined action of the air, water and minute animals would soon render ordinary wood rotten and useless.

CONSTRUCTION OF BUILDINGS.

As a general rule the type of buildings used for the manufacture of asphalt products are of light frame construction, sorely in need of repairs, located in a remote place with unpaved streets and little or no fire protection. In the mind of the writer if the plant is located in an isolated section (provided the protection and roads are all right), it is a better risk, as this class should never be located in a "built up" or growing section, because it is a nuisance and thereby likely to be destroyed by some one for revenge. The new plants now being erected are absolutely fire-resistive in all details (either reinforced concrete or steel framing well insulated) with the floor openings in terra cotta or concrete shafts and labeled fire doors at the openings and all exterior openings wired glass in labeled frames.

MANUFACTURE OF PAVING ASPHALT.

Refined asphalt is brought in wood barrels or metal drums (no refining done on the premises). The asphalt is then placed in direct, coal-heated kettles (brick set, open iron) or brick set, steam-heated kettles. The flux (a heavy residuum mineral oil) amounting to about 15 per cent. is then added (see under "Refining" for a description of this oil). This mass is allowed to cook at a temperature of from 250 degrees to 350 degrees Fahrenheit for about four hours. The oil and asphalt thoroughly mix during this time, the mixing being induced by the heat in conjunction with a compressed air agitation, the air being released at the bottom of the kettle.

After the cooking the heated mixture is conveyed by buckets into mixers, where cracked stone and sand from steam-heated rotary dryers are added in producing the first or binder course, the percentage generally being about 10 per cent. asphalt to about 90 per cent. sand and stone. The finishing coat or layer is pro-

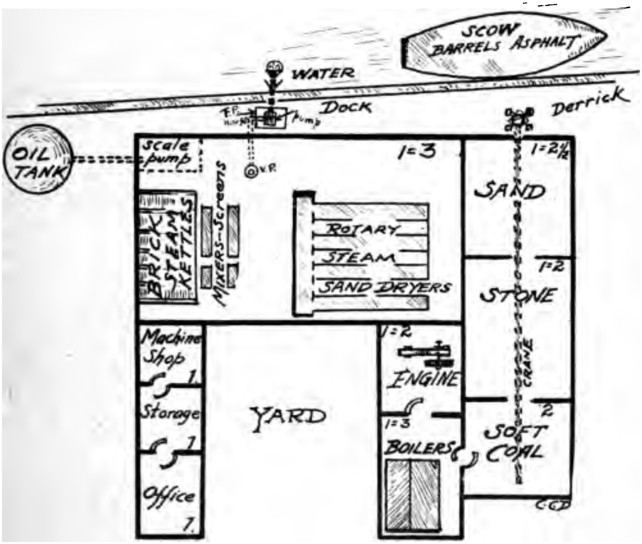


FIG. 1. A MODEL ASPHALT PLANT.

Fire resisting construction throughout, with cut-off fire sections. All-steam process, electric lighting, oil tank safeguarded and standpipe system. No refining in this plant.

duced by mixing 9 to 12 per cent. asphalt, 5 per cent Portland cement, and about 85 per cent. sand. The kettles used resemble large direct fire, brick set bake ovens, having an eight-inch segmental brick shield over fire-box with an air space of from sixteen inches to twenty-five inches between the shield and bottom of the kettles. The oil or "flux," which is usually located in an elevated tank some distance away, is conveyed through a pipe and pumped to the kettles.

REFINING.

Although this part of the business is seldom carried on in asphalt plants of to-day, the experienced inspector on visiting a plant will at once ascertain if there is any refining. Usually this work is done in an outlying section, perhaps miles away from the plant proper and the refined asphalt is shipped to the various plants in drums or barrels. The process, briefly described, is as follows: Crude petroleum having an asphalt base is brought by ships from Trinidad and pumped into tanks. It is then drawn from the tanks and pumped into coal-fired or steam-heated stills. Vapors from these stills are condensed in steel condensers and cooled by salt water. The flash point is said to be from 120 to 150 degrees Fahrenheit. After a distillate or what may be termed burning oil (flash 300 to 350 degrees Fahrenheit) is distilled off, the residue with a flash point of from 300 to 450 degrees Fahrenheit, is left at the bottom. This residuum or flux is a black tarry oil just a little lighter than water. It is this residue which we find in the asphalt plants in our vicinity being used as the "flux." Oil of turpentine is sometimes used as a solvent.

Von Schwartz's *Fire and Explosion Risk* says: "Natural asphalt has the specific gravity 1.100-1.200, melts at 212 degrees Fahrenheit, forms an almost coal-black mass, and contains volatile oils furnishing inflammable vapors exploding on admixture with air. To eliminate these substances the asphalt has to be warmed to 340 degrees to 445 degrees Fahrenheit until all the volatile oils have been driven off. This operation is dangerous, but the resulting asphalt is far safer than before. Well purified asphalt should not lose more than 2 per cent. in weight when heated to 437 degrees Fahrenheit for six hours, any greater loss indicating imperfect purification and correspondingly increased danger. Most of the agents employed for dissolving asphalt are dangerous (benzol, petroleum, carbon disulphide and ether, though the latter is merely a partial solvent), and hence the resulting solutions are dangerous to handle. A special warning must be uttered with regard to the inflammability and consequent ignitibility of asphalt when applied to any surface. Though inflammable, asphalt does not burn with readiness; nevertheless, burning asphalt forms a very dangerous disseminator of flame, the more so because it is difficult to extinguish. All articles that have been coated with asphalt, more particularly as a protection against moisture or decay, thereby acquire a high fire risk

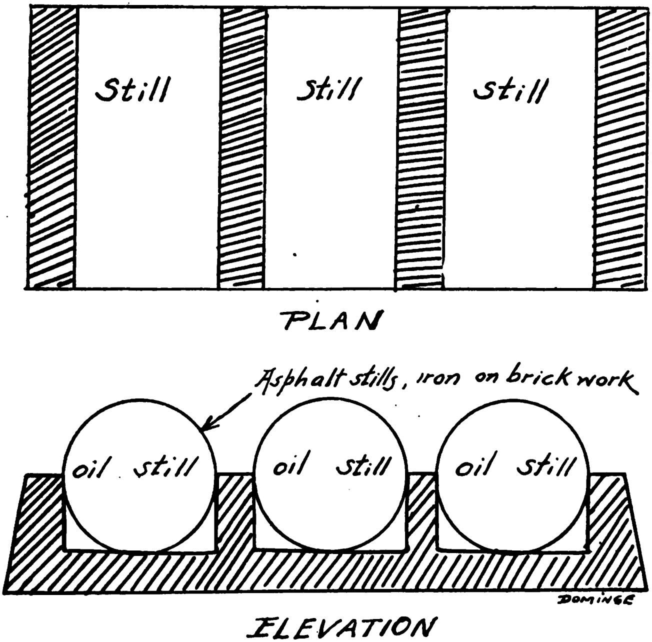


FIG. 2. AN IDEAL "STILL" BUILDING.

and this work must not be performed near any open fire or lights."

THE OIL STORAGE TANKS.

The writer a short time ago witnessed the demonstration of a new automatic chemical device for extinguishing fires in oil tanks. Briefly the following took place:

A large tank was nearly filled with water, above which was a layer of Mexican crude oil 5 inches deep and above this two buckets of gasoline were suspended to facilitate ignition. The gasoline was ignited by an electric spark and the oil began to blaze and flames were shooting up about 10 feet when from 4 upright sheet iron tubes at the sides of the tank, streams of a white fluid poured out and in 9 seconds the flames had disappeared. To obtain this result chemicals were placed in the four upright tubes, then sulphuric acid was added to them, transforming the contents into a foamy substance of which the principal ingredient is carbon dioxide (a gas that is deadly to flame).

At the top of each tube is suspended a receptacle containing sulphuric acid and held in place by a wire which extends across the tank and is fastened to similar wires from the other tubes by an easily melted metal. When the oil in the tanks takes fire the flames melt the metal wire holder, releasing the sulphuric acid receptacles and starting the chemical action.

Provision should be made so that in case of fire the oil can be drawn off to another tank away from the fire zone.

THE FIRE HAZARD

consists almost entirely of lightning striking the oil storage tanks. For this reason lightning rods should *not* be attached to tanks because they are apt to attract the lightning and as there are more or less explosive vapors at the top of the tanks, the flash when the lightning strikes the rod is likely to ignite the vapors, which in turn would cause the oil to burn. The open flame is also a serious hazard but in up-to-date plants no fear is occasioned from this quarter as all stills, heaters or dryers, kettle furnaces, etc., are heated by steam and the lighting is electricity with vapor proof enclosures and with switches located on the outside of the plant proper. Old-fashioned plants still use the "direct fire" heated furnaces which have been the cause of most asphalt fires. One can easily see how the asphalt and oil mixture when boiling is liable to come in contact with the naked flame. Where open flames are still used the inspector should recommend a draw-off valve and a flanged shield so that any overflow will not find its way to the flame.

ACTION OF FIRE.

Asphalt behaves in two different ways in the presence of fire:

1. Spreading flame when applied as a thin coating on objects.
2. Preventing the transmission of heat when as a compact mass in walls and floors.

SPONTANEOUS COMBUSTION.

Von Schwartz says the practice of adding oil of turpentine to asphalt, before or after melting same, may easily result in spontaneous ignition.

FIRE PROTECTION.

Although the insurance engineer fairly dotes on automatic sprinklers, this is "one class" where they are not recommended by most experts. Plenty of sand and chemicals would give a better account of themselves in conjunction with a standpipe system to put out the incipient fire among the woodwork. All storage tanks should have a permanent electrical ground, so that in case of being struck by lightning, this may prevent the ignition of the contents.

IN CONCLUSION.

Asphalt plants have been decidedly unprofitable to the insurance companies. Most experienced underwriters being "wise" to the physical hazards encountered in melting and fluxing asphalt. It is a well-known fact that fires once started are hardly ever extinguished. In the new plants now being erected, i.e., fireproof construction and all steam process and no refining, if the insurance form shows the major portion on raw asphalt (which will hardly burn) and the buildings are well cut off, this business ought to prove fairly profitable.

THE INSURANCE ENGINEER.

A Comprehensive Thesis on the General Qualifications of and Demands Upon the Competent Inspector.

By William S. Wensley, New York.

A generation ago fire insurance was conducted on this basis: "This is a business of chances, therefore take all the chances you can for the money you get." The main difference between the method then and now is that now the chances are taken on information obtained by inspection instead of in ignorance of conditions which should determine the acceptance or declination of a risk. Inspections then did not afford data for intelligent rating. There might be as many rates as there were policies on a risk.

About 1870 manufacturing methods began to be much improved, and this introduced new and almost unknown chemical and other hazards; unknown to the manufacturer whose property was at stake and to the inspector whose company would have to reimburse the owner for his loss. Owners were much interested in the success of their processes and only a little concerned about any attendant fire risk. Their own ignorance left them, and often the insurance companies, in the dark as to the causes of fires.

It was natural for manufacturers with new ingredients or processes to object, as they still do, to inquiries by enterprising special agents or inspectors. It was hard, therefore, to discover causes of fires and to prevent their repetition. By possession of more technical knowledge, they have learned how to make successful inquiries. A fire marshal of Philadelphia by his shrewdness discovered the cause of the bad explosions in chemical storage warehouses, which the owners with their superior chemical knowledge had not been able to determine.

Even so late as 1890 insurance companies could be grouped into two classes, those who preferred to insure risks with unguarded hazards for good rates, and the more progressive ones who wanted lines where the unnecessary hazards were reduced, and who would write those lines for less rates. The latter companies required more intelligent and painstaking inspections of their risks.

Before that time, however, companies had combined to inspect risks to rate them and then to inspect and report on hazards and protection free from the influence of any question of rate. One reason for this double inspection is the temptation to the rating inspector to modify his information to fit his rate, which he may have had to make to meet competition or to please the local agent.

In the '80s the automatic sprinkler piped its liquid note, and a well-intentioned but uninformed agent or broker could get 50 per cent. reduction in rate when he said a risk had a sprinkler equipment. After some experience with unreliable heads or equipments it was recognized that complete information as possible about sprinklers should be obtained for the companies. The inspectors not only examined installations, but tested heads for reliability and reported results to their employers.

The gradual development of the plan of expert inspection of risks finally demanded and produced the insurance engineer.

What must an insurance engineer look for, consider and report on? To suggest how thorough an engineer's seeing and thinking must be, let me mention only a few of the host of things which he must see and consider.

First, he must look for anything which will cause a fire. It may be mechanical, such as friction from a shaft not running true and setting fire to oil at the bearing or on nearby woodwork, or friction from a chafing belt.

It may be a chemical cause, as volatile vapor from a lacquer flashing at a low temperature, spontaneous combustion of oily waste, water dripping through a leaky roof into a barrel of lime in a shed, or moisture in a deep pile of soft coal against a frame partition.

It may be an electrical cause, as an open fuse above burnable material, or an electrical flat-iron on an unprotected table, or any one of the many defects in an electrical equipment.

It may be from a steam pipe around which lint has collected, which may catch fire and set the well-dried wood nearby on fire.

Or the cause may be radiated heat from the boiler dome, or a stovepipe, or furnace stack.

Direct flame may cause it, as back draft from a boiler blowing flames out into shavings being used for fuel where they have not been swept up tidily; or the wearing out and breaking of a rubber tube on a gas-fed heater where the escaping gas could ignite quickly at a burning light or stove nearby.

It may be an accidental cause, such as a hot coal dropping from a stove grate onto a wooden floor lacking metal covering about the stove.

While an inspector will see the ordinary hazards common to most factories, he will give his special attention to those peculiar to the class of risk he is inspecting and be alert for anything new or unusual. There are scores of old ones.

He will also look for that which will feed a fire, or increase the loss, such as the frame material in the construction of a building, leantos, walls and partitions, windows, ceilings and roofs, floors and supports, stairs which may not burn but be destroyed. (After the Baltimore conflagration marble stair landings an inch and a half thick could be broken more easily than a lead pencil.) Light brick construction which will fall or be pulled down when timbers fall; iron or steel unprotected, in an otherwise fireproof building, which could twist and be damaged even if it did not tumble and take something with it. Large quantities of inflammable stock, or finished stock to which has been added the cost of the labor to produce it, should be reported.

For the benefit of the insurers of use and occupancy, any limited raw stock, or machine which has to be made to order, should be mentioned.

He should report that which will extend a fire, as openings in walls, open well-holes, open stairways and elevator shafts, chutes and beltways. Owners fail to appreciate the importance of screening thin-glass skylights and do not seem to know that the upward draught of a fire is strong and will whirl burning material high in the air and will carry it a long distance, and by its weight or heat break through the glass and set fire to material inside below.

He ought to note what there is which will not help to extend a fire, such as non-inflammable walls, fireproof floors and supports, outside stairway and elevator shaft properly cut off, windows with wire glass and metal sash or with fire shutters, blank walls or standard fire doors between buildings, good distance of buildings from exposures, particularly from lumber yards or big oil tanks.

The inspector must consider the relation of one thing to another. If, contrary to unwise custom, the card room is below the finishing room in a mill, so that the usual damage to finished stock from a card-room fire would be reduced, assured should be given credit for that arrangement. If furniture finishing is done on the top floor of a building in which the floors are supported by tie rods from the roof, the arrangement endangering the whole structure, that should have special attention in the report. He should not recommend fire doors in a wall between two buildings if one building has an ell which is exposed through many windows in an angle formed by both buildings and those windows are to be left unprotected. He should not recommend that a watchman be employed (whose wages would be $500 a year) if that would equal the present premiums on assured's insurance.

He will be sure to see and state what there is to hold a fire in check until the fire companies arrive, or to put it out in its incipiency; pails of water or sand and whether they are full. If they are full and there is no dust on top of the water and the floor is wet under them he will know the reason for his detention for a half hour in the office when he presented his card. He will tip chemical extinguishers to see if they are empty and find out when they were last refilled. He will note whether hose is in good condition, is attached to standpipes and has nozzles when he counts the lengths. He will not test any apparatus himself and assume responsibility for maybe large accidental damage, but induce the assured to show its reliability. He will look into the top of a sprinkler tank himself, unless ice on the ladder or its exposed position make it too dangerous, no matter how positively the engineer may assure him that he filled it that morning. He sometimes will find it empty, notwithstanding. Even in a property where the pump is in the care of an intelligent engineer, who appreciates the importance of having the fire-fighting equipment in order all the time, the inspector will occasionally find a valve stuck so it cannot be opened quickly enough. If a pump draws from a creek, he will inquire about the depth of water in the dry season, whether the suction is in a crib sunk in the bed of the creek so as not to suck air, what the arrangement is to prevent the crib from filling up with sand, gravel and leaves, and how often it is cleaned out.

If there is a sprinkler equipment, he will follow pipes from start to finish. If it is a complicated one with many valves, he will make sure that the engineer knows all about them. There is record of a system with a supposed supply pipe which did not run through a wall to connect to water.

Of course he will tell what may be relied upon to put out a fire if it gets headway. If the risk is at the end of a street or some distance from cross streets or outside of the town, but has a sufficient supply of public hydrants, he will inquire whether they are on a dead end or loop; if in town but near the outskirts, he will ask whether they are on a gridiron system.

Is there a local fire department available. and what is the distance to the nearest company; its kind and character, volunteer or paid; condition and quantity of its apparatus? Is it uphill to the risk and are the streets likely to be in bad condition in winter? Would the department have to cross a drawbridge, which might be up when an alarm would be sounded, or would the hose have to be stretched across a railroad track and probably be cut by a passing train? Is the risk accessible on all sides?

Can the watchman speak English so he can use the telephone if that is the only alarm, or answer any questions the firemen may ask about hydrants, valves, stairways, or explosives in the buildings? Is he acquainted with the details of the sprinkler equipment, so he can shut off the water when the fire is out and prevent unnecessary water damage? Does he cover all the plant, or at least the necessary rooms, in his rounds? Are they frequent enough and does he hurry too much during each trip, and so maybe overlook something which might start a fire?

The most difficult and the most important point on which to get information is the moral hazard. Only a few questions are: Business prosperous? Help intelligent? Reasonably easy to get a plentiful supply of raw stock? New process or up-to-date machinery, or capital too small to buy more modern appliances? What has been the fire record?

The fragmentary foregoing suggests that a risk may be described as an aggregation of several hundred facts. An inspector must go after all the facts and be satisfied with nothing less than positive knowledge about all of them.

Multiplicity of facts need not discourage any man from attempting to inspect the largest plant. Let him first provide himself with a ground plan of the buildings and then let him remember that an expert can inspect only one room of one story of one building at a time and that that is something any fairly competent man and he can do. Experts are not born, but educated by experience, thinking and study. Inspection work and fires will supply enough of the first, he can do the other two.

If an inspector will devise a simple code of signs for different kinds and parts of construction and for other things he must notice he can make his notes quickly, and because they are in short space he can write his report more readily.

If a young man has the right material in him he will not work merely for his salary or his livelihood, but because he fills some place in the general plan for the common good. He can be enthusiastic about his work if he is a fire insurance inspector, for several reasons.

So long as this country continues to build frame structures, so long as governments, municipal and State, are derelict in making and enforcing laws to compel proper precautions against fires, just so long will there be need for inspection by men alert to discover undesirable conditions, and point out how to reduce the loss.

Brokers with good intentions, but with a natural prejudice due to their commission interest, are optimistic in their reports about risks. Local agents, to lighten their own labor in placing poor risks, of course say the best they can about them. Special agents with numerous other duties cannot take the time for the thorough inspection they would like to give them.

When mutual companies write a risk at a very low rate and promise that only one inspector shall visit it, the stock companies need to reduce the expense and number of their inspections and have able men to plan the details of as complete a system of protection as should be provided.

An inspector's work affords him a variety of experience with men and factories. He may meet an unpolished, surly, well-dressed owner in the office or an educated, good-natured electrician in overalls and jumper in the dynamo room. He may see men cut up animals in an abattoir on Monday, wash down care in a brewery on Tuesday, and prepare beautiful raiment in a silk mill midweek; he may sample sweetness in a candy factory Thursday, get sick in a fertilizer works Friday and end his week's troubles in a coffin factory come Saturday. The inspection of hazards is the physical foundation of the business. When he learns enough of it he can build his superstructure of rates, underwriting, adjusting, etc., etc., afterward, and attain big position with large compensation sooner than through the old way of clerical office position. There are enough incentives.

INSPECTIONS SHOULD BE WELCOMED

by the assured. If the owner of the average special hazard risk could refuse to have his property inspected and still get all the insurance he wanted without trouble, it is a question whether he could afford now to have such examination omitted. A superintendent attending to satisfactory and economical output ordinarily overlooks some of the points patent to the eyes of the trained inspector. Even if his intentions are good, unnecessary hazards creep in, apparatus gets old, like a stovepipe, and causes fires; or becomes inadequate, like a boiler, and is pushed beyond safety; or a blower system, and is overloaded; or is neglected, like a fire pump, from lack of time if assured is busy. Or familiarity with danger causes employees to neglect precautions, say with electrical equipments or in handling volatile liquids. If the danger exists undiscovered, the owner cannot afford to lose the inspection which brings it to his attention for remedy. A change in construction or a new raw stock or machine, a process or chemical combination, the storing of two chemicals in a room or one chemical indoors may present a new or unthought-of hazard. Inspectors discover these, point them out and suggest remedies. If there were no inspections made of electrical apparatus other than those by the municipal authorities, would not the losses from electrical causes be largely increased?

New preparations are put on the market and claimed to be without fire hazard. They are often used by the assured in ignorance of the inflammability of their ingredients. An assured will sometimes claim that a certain raw stock or his own product is non-inflammable, and is totally surprised when a test proves the contrary to him. The average assured believes his tank holds more water than it does and will largely overestimate the capacity of his pump.

The factory employee does not know that the inspection is largely in his interest as well as that of his employer. If a serious fire occurs, it probably means not only loss of business to the owner for weeks or months or for good, but of wages to the help for a good while. It may mean necessary removal to another town to find employment, and meantime the sacrifice of many comforts if not necessities to their families. Fire insurance inspection helps to keep a factory going and to continue the prosperity of the manufacturer and his employees, safeguards the happiness of their families to some extent while it is preventing losses for the insurance companies. Although an inspection may come at a time inconvenient for the assured, he can well afford to welcome it as adding another safeguard to his own interests and the welfare of his employees.

With so important a work the inspector may rightly feel that his time is so well occupied that it calls for his best effort. As his occupation touches every other business, and is therefore as broad in its scope as the business activities of his contemporaries, the best he can do is none too good, the most he has to give is none too much. He may well rise to the height of the sentiment, "Who gives himself gives best," and devote his life to his calling.

What, then, should be his preparation? In what way can he make it most complete?

For convenience you may divide men into four classes: First, you have the man lacking education and gumption; second, the one possessing the education, but not the gumption; third, the man minus the education, but having the gumption; and, highest of all, the individual blessed with both. The first and second, of course, should not be considered as candidates for inspectors. The third and fourth may make first-class inspectors provided they have other qualifications.

A candidate may have gumption and may have graduated from even one of the best technological institutes and not make a good inspector. He may have common sense and lack the technical education and yet make a good inspector. If he has both and some natural aptitude for the business he may make the very best of insurance inspectors. A man should not be refused because he lacks a college education or accepted because he has one. The preference should be for the technological man, other things being equal, because he has the desired grounding in mechanics, hydraulics, electrics and chemistry. There are men who do not understand machinery, to whom a complex machine is a mystery, and they do not have the mechanical sense to know how to analyze it to see how it does its work. It does not seem that such a man could make a good inspector.

If a candidate has been taught about boilers and engines, machines of different kinds, and pumps, he will find his knowledge useful in a variety of ways as an inspector. He would not recommend an exhaust fan for shavings, for instance, if the steam capacity of the boilers would be overtaxed. He can determine the capacity of a pump, and, if it is out of order, tell what is the trouble with it, or prevent the engineer from making only a partial test of it. If he has had practice in mechanical drawing and has some invention he can draw a sketch of a defect in an appliance or its arrangement and another of how it should be improved, particularly if the wisdom of his recommendation for improvement is called in question. That rarely fails to convince the assured that the inspector knows what he is making a recommendation for and just how it can be made safe.

If he has electrical knowledge he will know electrical hazards which are not apparent on the surface, but inherent in a machine.

If he has gone into qualitative and quantitative analyses in chemistry he will appreciate a hazard so soon as an assured mentions two raw stocks which have an affinity for each other. The average inspector does not know enough about chemistry. Superintendents of chemical works could fool many of them if so disposed. On the other hand, knowledge commands respect. An inspector once found a cold superintendent, who gave monosyllabic answers to questions until he mentioned an unusual raw stock. The inspector named the symbol; the superintendent brightened up at once, thawed out and became communicative.

As an inspector's work is the physical basis of the insurance business, he therefore should be his company's senses while inspecting a plant. If he has not a natural habit of observation, it must be acquired at once, or otherwise he will not see things which are in sight, and he will be a failure. When the average person goes through a doorway he does not look to see whether it has a firedoor and whether it is standard in all respects. The inspector must. When he enters a room he must see not only the four walls, floor and ceiling, but everything in the room. The habit of observation grows as any other does. An experienced inspector sees much and at a glance. He must not only see, but he must know and not be talked out of what he knows. An assured will often deny the need of a change recommended, but if the inspector absolutely knows what he saw and can give even the small details, the owner is in doubt enough to make an investigation of the thing complained of and will apply a remedy. While an inspector's sight becomes quick, it must never be superficial, but thorough. To see everything about a risk he must go everywhere about it. If he goes thoroughly into the subject of a complicated set of valves controlling yard mains or sprinkler pipes he may know more about them when he gets through than the engineer did. If he finds a sprinkler system out of order temporarily he should remain overnight maybe to hasten its restoration or to make sure that it has been put in order.

A good sense of smell will sometimes tell the insurance man that the assured has misinformed him when he said there was no benzine on the premises. If the inspector happens to have a cold a finger dipped in benzine will become dry and have a slightly unpleasant feeling, while turpentine will not have the same effect.

While ordinary hearing is all that is necessary, an inspector should be a good listener. It is better to induce the owner to talk than to talk much to him. If he is not disposed to have his factory inspected that day, but is inclined to decidedly uncomplimentary speech about insurance companies in general and inspectors in particular, it is well to let him talk out all his bad feelings. If the inspector will remember that he is not there and would not be there in his individual capacity, he need take nothing said as personal to himself, and give no answer at all or the "soft" one "that turneth away wrath," and more than likely the assured will be ashamed of himself and apologize or make amends in some way. It takes only a ten-year-old to say, "You're another," but it takes a man's skill to bend the assured's temper to the inspector's will and purpose, and that can best be done by holding one's own temper in check.

AN INSPECTOR'S INGENUITY

is sometimes superior to that of an owner who has thought a change was impractical. There was one proprietor who, before the surveyor had time to examine an oven, said he would cancel his insurance rather than make any change. When the inspection was over he asked how things had been found. The inspector said, "Very good, except the oven." "What is the matter with it? There is nothing near it to burn." "It could set fire to the ceiling and it could be put in another part of the room under the metal ceiling just as well." "I never thought of that; I'll change it." Then he invited the inspector to go home with him to dinner. On that being declined he urged the inspector to go across the street with him to get a bite before the train came.

There have been, and there may be to-day, inspectors who feel that an assured must do as they say, and who do not exercise as much tact as may be necessary. The average owner is a man ready to listen to reason. The inspector should keep in mind that the manufacturer is not in business solely to get insured, and that there is a reasonable limit to the sum that he can spend for improvements. When there is an important defect, when the owner cares only for dollars and has the well-nigh universal conceit that his property is the best in the country to insure, an inspector's best qualification, his tact, should be brought freely into play. It is something which can be cultivated. A persuasive tongue is a valuable asset. One inspector's shrewd and successful plan was to induce the assured to say how he would arrange a thing if he were going to make any change in it. He will follow his own plan when he is unwilling to adopt one proposed by an inspector. One should always show a preference for the assured's method of improvement if it is good enough.

With his tact he should combine polite firmness. He should part in good humor from a man who would browbeat him, but leave him with the conviction that the inspector regards a serious defect as needing a remedy, and that his company will no doubt take the same view. If the owner quotes a difference of opinion of inspectors, an appeal to his own good judgment regardless of theirs will often be effective.

Besides quickness and accuracy of observation, which becomes habitual with an inspector, the memory of the average one becomes much improved because he follows its two natural functions, getting an impression while seeing a thing and reviving that impression when making out a report. He also develops a habit of instantaneous judgment, as busy men in other occupations do. Occasionally he runs across a new or complicated condition, so that he has to sit down on a box or the stairs and think out a logical conclusion. He may have to ask many questions to determine whether an apparatus is arranged safely or not; as, for illustration, an underground series of piping for a fuel-oil system. His own judgment must be convinced as to its safety regardless of the opinion of the assured or his engineer. If he finds the assured wrong, his own clear statements or reasoning must be convincing. If possessing skill in persuasion, he should induce the owner to remove a defect, even if at some cost.

A man who gathers knowledge by his keenness and skill should have the ability to impart it correctly to others; the more concisely and completely, the better. A recent writer in a magazine pointed out how difficult it was to teach enough English to the students. Some one has said wisely that "The greatest of all scholastic attainments is the art of expression; by it is knowledge made useful, and in all countries the greatest orator governs the most men." The inspector should by all means cultivate the greatest attainment of the schools; he should at least write exact English.

THE IDEAL INSPECTOR

is the one who anticipates not only fires from known causes, but those which would have an entirely new origin, or whose forethought points out that which must be looked for in new protective apparatus. Most of the progress so far has been from "post-mortems." Analysis is good, costs money and we must have it, but forethought is better because cheaper. A surveyor who made a second inspection of a factory noticed nothing new and disliked to return in a report just like his last one. As he looked about to see if he couldn't find something new he wondered if the old Brown sprinklers had deteriorated. A test of some heads resulted in new equipments in three factories. When we come to a new thing in our business, whether it be of construction or hazards, protection or combination of some or all of them, it should be considered from the standpoint of every imaginable probability, if not possibility.

Just as an inspector who has had experience with a hundred factories of a given class sometimes knows more about the hazard of that class than a manufacturer in it, so he may know more about what is requisite in a fire pump, for instance, than the manufacturer of a single make of pump knew years ago. It was probably the foremost insurance engineer in the country who discovered by experiment with different makes of pumps that the piston traveled twice as fast at the middle of the stroke as at each end. Larger pump valves were the result.

The insurance engineer stands as a factor of safety between the architects and builders and the insurance companies, and between the maker of an appliance and the factory owner who would buy it. Few such owners know or appreciate it. To some extent he stands between the careless or dishonest manufacturer and the careful and honest one making the same kind of appliance. He fills his part by recommending standard goods. His tests operate as a check on the makers of unsafe chemical compounds, or appliances claimed to be safe. Maybe his highest employment yet is in recommending legislation for better buildings, reserve pumping stations, additional fire houses and apparatus, etc.

The insurance engineer of to-day is as much in advance of the sprinkler inspector of twenty years ago as the latter was ahead of the local agent as an inspector maybe twenty years before that. A score of years hence the educated, earnest young men now in the business may be able to boast truthfully of still another equal advance; they are a guarantee that the profession shall go forward.

Another word about the assured. He has as many characteristics and attitudes as humanity, and he is the man who has the last word in inspection. You may recommend fireproof construction, but if his pocket-book will not stand it, he says so. He is the most important personal equation of the risk. He may have ignorant help, but if his discipline is good the physical hazard is reduced. His appreciation of the hazards and his attitude toward recommendations should often determine the desirability of the risk. You may hear the echo of the shriek of one assured, "Insurance is a curse," and yet you may smother it with a skilful statement of fact and experience, reasonable argument and tactful persuasion.

Many factory owners seem to regard an inspection as an unavoidable evil which must be endured; they "suppose the inspector must make a recommendation about something to hold his job." They make no allowance for any alterations they may have made since the last inspection, which added to their exposure or unnecessarily to their hazards or hurt their sprinkler equipment. In their yearly inventory they make allowances for the deterioration in their machinery, but make none for their fire appliances and begrudge the spending of any money on those. They used to tell you frankly that all they put them in for was to get a reduction in rate. They may have saved the cost of their sprinkler equipment twice over in premiums since it was put in, but are unwilling to spend money to bring it up to modern standard and greater effectiveness. And yet let it be said truthfully, and thus optimistically, that experiences with the average owner have shown beyond any question that he is reasonable and will make changes which you prove to him are wise. He will even make changes which are unwise because he has misunderstood or forgotten just how they were to be done; he will, for example, put a tin-clad door in a wall with a transom unprotected above it. He will tell subsequent inspectors that that is what the other one recommended; and some inspectors will believe it!

He will write procrastinating letters to the office about improvements just so long as they will be accepted, or he will say that the work has been done when he has only ordered it, and his superintendent afterwards forgets the order. He will write non-committal letters, or some skilfully worded to make it appear that he has promised to do everything requested. He may give you specific reasons why each recommendation should not be adopted and his conclusion that all of them were ill-advised. And yet this is the man who spends his money, even when he differs with you as to the wisdom of it, to make his property a better risk for your company. The inspector should be careful then and consider the assured's pocket and recommend only what sound judgment dictates. He can afford to be patient with the owner, to hear his story all through, consider carefully everything he has said, modify his own recommendations if possible, sympathize with the assured because of the embarrassment he has caused him and then love him a little because he is so much like ourselves.

Then there is the wise factory owner, who has the keenness to know that you are an expert, a specialist, come to offer your best services in his behalf, to discover with your keen eyes what he has not seen because his mind and time have been engrossed with plant and raw stock, machinery and process, output and profit; to share with him what you have learned from defects or losses in similar risks, about appliances or conditions, or gleaned from technical reading or exchange of experiences with your associates; to get your best judgment on any subject which concerns the safety of his plant from fire, in mutual interest, and which will prevent an annoying and costly interruption to his business. He is the ideal assured. He stands ready to make any change which appears reasonable after full consideration of all the circumstances.

As the insurance engineer looks back he can see bright spots, which should give him encouragement for the forward work of the future. Because his business must include knowledge of the advance in every other, and he must meet that advance, his business will continue to be as progressive as any other and the most comprehensive business in the world. Good success to him and greater profits to the company he represents!

FIRE HAZARDS OF MOVING-PICTURE THEATERS.

Discussion of Proper Precautions to be Taken in the Building, Equipment and Operation of Film-Display Houses.

By the Inspectors and Engineers of the Travelers Insurance Company.

Probably the best symposium on the fire hazards of moving-picture theaters that has been prepared has been published in a booklet entitled "Safety in Moving-Picture Theaters" by the engineering and inspection division of the Travelers' Insurance Company of Hartford. The book is copyrighted, and its subject-matter is here republished by special permission of that company, to whom credit is due also for the illustrations. The treatise is as follows:

GENERAL CONSTRUCTION OF BUILDINGS.

The exterior walls should preferably be of masonry, or of structural steel and masonry, although concrete work with stucco ornamentation also provides a satisfactory fireproof construction. Concrete may be advantageously used for the floor, as it gives a clean, smooth, fireproof surface, which can easily be swept and kept in a sanitary condition. Auditorium floors when made in this way are sometimes washed daily by means of hose streams, the waste water being allowed to drain off near the stage. The floor in the auditorium should be made flush with adjacent floors at all entrances and exits.

Interior walls and partitions should be made of fireproof material throughout, and whenever doors or window sashes are required they should also be made of incombustible material. If windows are used in partitions they should be made of wired glass not less than one-quarter of an inch thick. Mirrors are often placed along the walls of lobbies and corridors. These are likely to prove dangerous, however, and should be omitted or removed. Mirrors that may give the appearance of exits are especially objectionable, and there should be no false doors or windows, nor other architectural devices in lobbies, passageways, or elsewhere, that might lead persons to believe there are exits where none exist.

Guard rails should be installed along the edge of the balcony directly over the auditorium. The tops of these rails should not be less than three and one-half feet above the floor level at the front of the balcony. An excellent railing may be made of two-inch metal pipe, substantially supported at intervals not exceeding ten feet.

In modern theater construction cantilever trusses or plate girders for supporting the balcony have largely supplanted the view-obstructing columns in the auditorium, that were a feature of earlier designs. In ordinary practice the balcony should be designed and constructed to withstand a safe load of at least 200 pounds per square foot.

VENTILATION.

An adequate system of ventilation is essential, and this feature should receive careful attention. The air should be distributed uniformly throughout the house, without causing drafts. Effective results are often obtained by locating the air-inlets near the ceiling and the outlets near the floor, although there is some difference of opinion in regard to the practicability of this system.

The change of air in theaters of this kind is usually effected by the use of fans, which force fresh air into the building through conduits. The amount of air required for each person varies according to circumstances. It is estimated, however, that in order to keep the air in a satisfactory state of purity there should be at least 40 cubic feet of fresh air admitted per minute for every person present. Adopting this figure as a basis, we have the following

RULE: To find the greatest permissible time for completely changing the air of the audience room, divide the volume of the room (as expressed in cubic feet) by the number of seats, and divide the resulting quotient by 40. This gives the maximum number of minutes that should be allowed for replacing the entire air of the audience room by fresh air from the outside.

EXAMPLE: Suppose the room to be 100 feet long, 40 feet wide, and 15 feet high, and assume the seating capacity to be 500. Then the volume of the room is $100 \times 40 \times 15 = 60{,}000$ cubic feet, and the rule is applied as follows: $60{,}000 \div 500 = 120$, and $120 \div 40 = 3$. In this case, therefore, the air should be changed at least as often as every three minutes, to insure its purity.

Electric circulating fans, when fixed by brackets to the walls along the side aisles, should be placed not less than 7½ feet above the level of the floor, and should be protected by wire guards. Fans arranged to swing in a semicircle are now quite commonly used.

Electrical devices have recently come into favor for improving the air in theaters and other public places. These are sometimes effective in getting rid of disagreeable odors and thus making the air seem purer, but it is doubtful if they are of further value.

Moreover, it is far better to circulate fresh air drawn from the outside, rather than to attempt to make over that which has become vitiated.

ENTRANCES.

The floor inside of the main entrance should be on a level with the street sidewalk whenever possible. This is sometimes impracticable, but every effort should be made to limit the difference in elevation to six feet.

When the number of persons accommodated in the balcony exceeds 200, at least two separate and distinct entrances should be provided for such balcony, and each of these should be not less than 5 feet wide. Entrance doors are sometimes constructed on a basis of twenty inches in width, in the clear, for each one hundred seats in the auditorium, with a proportionate addition for any fractional part of one hundred seats remaining.

EXITS.

The number of exits depends upon the seating capacity of the theater. In every case, however, there should be at least two exits leading from the main floor into open streets or avenues, through each of the side walls. Each exit should be at least 60 inches wide. The doors should swing outwardly, and should be fastened so that they may be quickly and readily opened from the inside at any time, without any special knowledge of their mode of operation. The use of draw-bolts cannot be recommended.

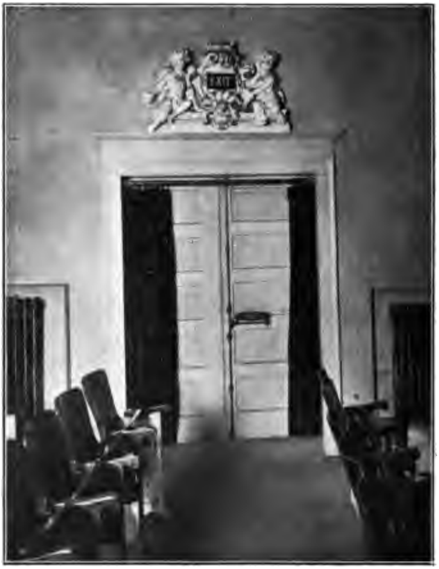


FIG. I. A WELL-ARRANGED EXIT.

(Note the wide cross aisle, the anti-panic door lock, and the recesses in the side walls for the radiators.)

We strongly advocate a self-opening arrangement, operated by merely pushing against a conveniently located bar or plate. (See Fig. 1.) All exit doors should be so constructed that when open they will not obstruct any portion of any doorway, opening, or passageway.

All fire escapes should be substantially constructed, and provided with strong, firmly secured hand-rails. When emergency exits and stairways are located inside the walls of the theater, they should be separated from the auditorium by a fireproof partition not less than four inches thick.

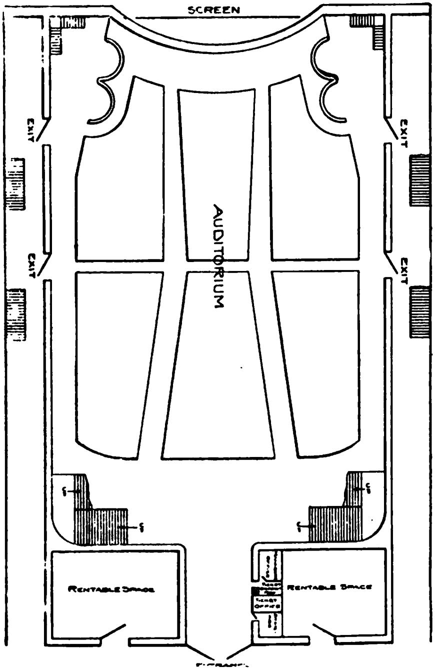


Fig. 2. Suggestion for an Auditorium Seating about 500 Persons.

A theater located between other buildings should have an external passageway on each side extending from the proscenium wall line to the street line at the front of the theatre. If the theater abuts on a street at both the front and rear, these passageways should extend the entire length of the building. The passageways should be not less than six feet wide throughout their entire length, and their sides should be parallel. It is also advisable to cover them over at a height of eight feet with brick or with some other fireproof material. Stores, offices and dwellings should be separated from the theater building by solid walls or partitions constructed of firepoof material, and their entrances and exits should be entirely separate and distinct from those of the theater.

Sidewalks and passageways leading from exits to main thoroughfares should be smooth, unobstructed and well illuminated. The passageways are often partially obstructed by boxes, barrels or other waste material, but this practice should not be tolerated.

STAIRS.

The risers of stairs leading from the main entrance to the main floor of the auditorium should be uniform in height. This height should not exceed 7¾ inches, and the treads should be at least 10½ inches wide. Wherever stairs lead downward from exits, there should be a space of at least one foot between the door opening and the edge of the top step. Stairways that extend to court or street grades should be entirely independent of one another.

All stairs should be provided with substantial handrails, and when the stairs are built between walls the railings should be firmly secured to the walls, and should stand out about 3 inches from them. This also applies to the side aisles of balconies. Railings used on stairs should be about 3 feet above the treads. Stairs and landings between balconies and main floors, when 7 feet or more in width, should be provided with center rails of metal pipe, not less than 2 inches in diameter, placed about three feet above the stair treads and securely fastened to them by flanges. Non-slipping stair treads of abrasive material of some kind are often used, and these, or others of an equally effective type, are recommended.

TUNNELS.

If the total rise of the balcony, measured vertically, exceeds twelve feet, a tunnel or passageway should be provided for an exit, and this should lead directly to a corridor or to the lobby of the theater. The tunnel or passageway should not be less than four feet wide.

SLOPE OF AUDITORIUM FLOOR.

The slope of the floor should be sufficient to permit persons at the rear of the room to clearly see the stage or screen over the heads of those sitting in front. but it should not be unnecessarily steep. A grade of 10 per cent. is sufficient to give a clear view from all parts of the auditorium, and when this standard is adopted it will be unnecessary to place steps in the aisles.

SEATS AND AISLES.

In boxes accommodating no more than fifteen persons it is usually unnecessary to have the seats fastened to the floor. In the auditorium, and in all other parts of the theater, however, the seats should be firmly fixed to the floor by suitable castings, each secured by at least three screws. Loose seats should receive immediate attention. The distance between the rows (as measured from the back of one seat to the back of another) should be at least 32 inches, and the width of each seat should be at least 18 inches. This will give ample room for the passage in and out, and will also insure comfort to the patron during the exhibition.

There should not be more than eleven seats in any one row, between aisles. If the aisles do not lead directly to an exit, cross aisles should be provided in the main auditorium, dividing the seats into blocks containing not more than fifteen rows each, and in balconies a cross aisle should be provided to every nine rows of seats. The main aisles in the auditorium should be at least 32 inches wide at the front of the theater (or at the end nearest the screen), and from this point the width should be increased at the rate of one-fourth inch per lineal foot until a width of 38 inches is attained. If there are seats on one side of the aisle only, the minimum width of the aisle should be 28 inches at the front of the theater, and this width should be increased in the same proportion as given above. The minimum width for the aisles in other parts of the theater should be 28 inches.

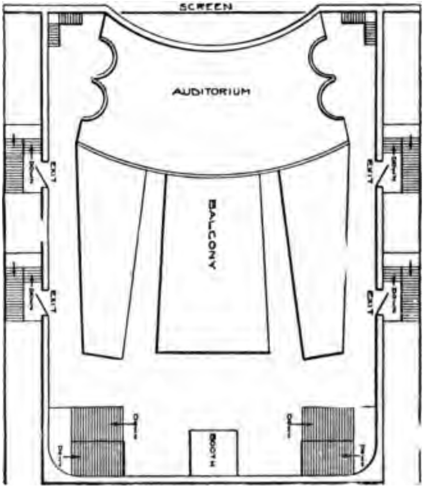


FIG. 3. ILLUSTRATING THE GENERAL ARRANGEMENT OF EXITS, AISLES AND BOOTH, IN A BALCONY.

When it is necessary to place hot-air registers in the aisles of the auditorium, these should be made flush with the floor, and all screw fastenings should be countersunk. Steam or hot-water radiators, when placed along the side aisles, should be recessed into the walls, so as not to obstruct the passageways.

Carpets and other floor covering should be firmly fastened, special care being taken not to allow the edges to roll or turn up, and to repair torn or badly worn places promptly.

LIGHTING.

The indirect system of lighting is well adapted for moving-picture theaters, as it gives a soft, diffused glow, which can be nicely regulated. The light is produced by means of incandescent electric lamps mounted in elevated fixtures that are closed at the bottom and entirely open at the top. The rays of light strike first upon the ceiling, from which they are reflected downward toward the audience. The effectiveness of this system varies according to the color and finish of the walls and ceilings. A glossy white finish will reflect the most light, but a slight creamy tint makes the illumination more pleasing to the eye.

There should be side-wall and ceiling lights along the side aisles, giving sufficient diffused light to enable the ushers to show persons to their seats without difficulty during the display of a picture.

A red light should be located over each exit door, and this light should be kept burning continuously during the entire performance.

ELECTRICAL SUPPLY.

The electricity for lighting the theater and for operating the moving-picture equipment should be obtained, when possible, from two separate street mains. One service should be of sufficient capacity to supply current for the entire installation and its accessories, while the other supply should be sufficient for all emergency lights, including the exit lights and the lights in the corridors, lobbies, stairways and other portions of the theater which are usually illuminated during the exhibition of pictures. In locations where only one supply can be had from the street mains, the emergency light circuit should be connected at a point on the street side of the main service fuses, thus insuring adequate lighting at all times unless some trouble occurs outside of the theater.

When theaters have their own electrical generating plants, storage batteries should be provided of sufficient capacity to operate the emergency lights in case of trouble with the generators. This method of lighting is frequently adopted in small towns where the public electrical facilities are limited.

The main service supply switches and fuses may be located in the operator's booth with advantage. The house lights can then be controlled by the operator of the moving-picture machine and can be lighted or turned off as conditions require. For occasional convenience, and for emergency use, an auxiliary switch box should be installed at some suitable point in the corridor or elsewhere. This box should be enclosed, and it should be constructed of incombustible material. The screws or bolts used for securing it in place should be countersunk, and effectively insulated.

The fuses should be of the enclosed type throughout the entire building, all the wiring and electrical apparatus should be effectively insulated, and the entire electrical equipment should be maintained in good condition in every respect.

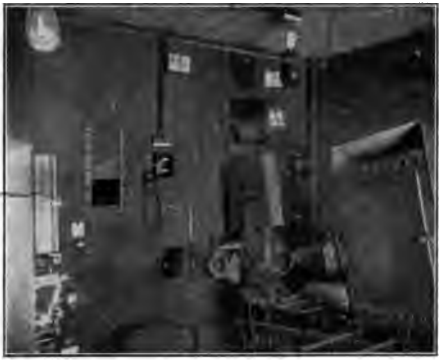


FIG. 4. INTERIOR OF BOOTH CONTAINING TWO MOTOR-DRIVEN MACHINES.

(Note the wall fire-shutters, held up by one inflammable master-cord that terminates directly over the machine head. Also the telephone communicating with the manager's office, and the general arrangement of the protective devices on the machine. The film shields, illustrated in Fig. 8, were removed before taking this photograph, so that the mechanism could be seen more clearly.)

BOOTHS.

When moving-picture machines first came into use they were not enclosed, unless possibly by structures of canvas, cloth or wood. The necessity for enclosing the machines in fireproof booths of some kind was universally recognized, however, after a number of disastrous fires had been caused by the ignition of the highly inflammable films, and laws were then enacted requiring such enclosures. Some of the requirements of the early laws were not entirely practical, and they have since been revised and amended quite materially. Approved modern practice in the construction of booths is outlined in the following paragraphs:

TYPE.

The booths should be constructed so they will not only confine possible fires within them, but also keep persons in the audience in ignorance of any such fires, and thus diminish the chance of panic.

There are three different types of booths, respectively known as portable, semi-portable and permanent. The portable booth is designed to be placed over the machine when the exhibition is for a single night; the semi-portable booth is constructed to meet the requirements of a permanent or stationary booth, but is used by traveling exhibitors; and the permanent booth is designed to be permanently installed in an established theater.

Authorities differ regarding the material that should be used in the construction of permanent booths. Asbestos, cement, brick and tile are variously recommended, but it is generally agreed that metallic enclosures should be eliminated as rapidly as possible, because they may become grounded and cause short circuits, thus starting fires which would otherwise be avoided.

LOCATION.

Careful consideration should be given to the location of the booth. Experience has shown that the average machine will efficiently project a picture to a distance of from 75 feet to 100 feet, although there are machines with special long-focus lenses which will project pictures to a distance of from 140 to 160 feet without consuming any more amperage at the arc lamp. The location of the booth, therefore, depends in a large measure upon the projecting power of the machine that is to be used. Whenever conditions will permit, it is advisable to locate the booth in some place above the balcony, and preferably at a point remote from any entrance or exit. It is also desirable, in the interest of good ventilation and for other reasons, that the booth should be as near as possible to the roof of the theater, and it may even project above the roof like a pent house.

SIZE.

Where only one machine is used, a booth covering a floor space of 6 feet by 8 feet is large enough to contain all the necessary mechanism and accessories, and to allow the operator freedom of movement. In most installations of recent design duplicate machines are used, the films being adjusted in one machine while the other one is projecting pictures. To accommodate this kind of equipment the booths should be at least 9 feet by 8 feet in their horizontal dimensions. Permanent booths should not be less than 7 feet high.

CONSTRUCTION.

A substantial frame may be made of 1¾ x 1¾ x ¼ inch angle iron, consisting of four members at the top and bottom connecting the corners, four vertical supports, and intermediate vertical members about 3 feet apart. This may be covered over by sheet asbestos, which is inexpensive, and which also meets nearly all the requirements for construction of this kind. The asbestos should be at least ¼ inch thick, and so arranged that the joints will break over the angle irons—the joints being filled with plastic asbestos. The door, which should be at least as large as 2 feet by 6 feet, may also be made of sheet asbestos, and it should have a spring attachment to keep it closed at all times. The flooring may be made of asbestos material, not less than half an inch thick. The lens opening and the operator's lookout port must be provided with fire shutters made of hard sheet asbestos not less than an eighth of an inch thick, or of metal, and arranged so as to slide in grooves. These shutters should be held open by fusible links having a low melting point, so that they will close quickly and automatically if fire breaks out in the booth. The shelves in the booth, and the rewinding bench, should be made of asbestos.

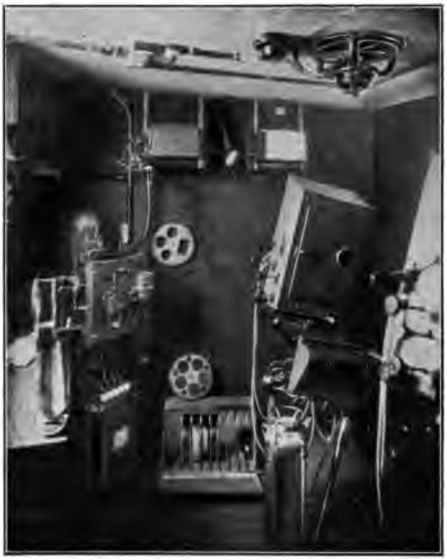


FIG. 5. A MODERN BOOTH EQUIPMENT.

(The electrical equipment is here arranged in an approved manner. Note the film-storage magazine, which is here shown open, and also the location of the ventilating fan. The house-light switches are not shown.)

Ventilation may be provided by means of a fireproof vent pipe from six to ten inches in diameter, attached to the top of the booth at the center, and extending up through the roof of the building and to some height beyond it. During the summer months the booth becomes very warm, and it is therefore advisable to have a fan in the vent pipe, to promote the circulation of air and thereby lower the temperature in the booth. In the winter a damper connected with a fusible link may be used to open the vent in case the temperature rises above 350° Fahrenheit. A fire extinguisher should be located within the booth, and another one should be placed just outside of the booth door.

MOTOR-DRIVEN AND HAND-OPERATED MACHINES.

Opinions differ with regard to the relative merits of motor-driven and hand-driven machines. Each type has its advantages and disadvantages, but either will give good service if it receives proper care. One of the arguments in favor of requiring the operator to turn the mechanism by hand is that he is obliged to be near the machine at all times during its operation. He must therefore give it his constant attention, and the claim is made that more efficient results will be obtained from it for this reason. The motor-driven machine does not require continuous attention from the operator, and hence he may not be ready for immediate action in case of trouble. On the other hand, it is argued that the substitution of the motor for the hand drive will not only materially reduce the labor, but will also leave the operator in a better condition, mentally and physically, for the management and safe control of the apparatus. Whichever type of machine is selected, its satisfactory operation is in a large measure dependent upon the competence and vigilance of the operator. A motor-driven machine of modern construction will, in our opinion, give economical and satisfactory service if it is made adequately safe in every possible way, and operated by a careful and experienced person.

ANCHORING THE MACHINE.

If the machine is not set solidly, there will be vibrations from the motor which will cause flickering of the pictures on the screen. The table should therefore be rigidly secured by sockets set into the floor in a substantial manner.

AUTOMATIC FIRE SHUTTER.

The rays from the arc lamp produce a high temperature where they are focused at the projecting aperture. When the machine is in operation the film passes this point so rapidly that there is no time for it to become dangerously hot; but the heat is intense enough to ignite the film in a few seconds if the machine is stopped in such a way that some one limited part or region of the film is left exposed to the condensed rays without protection.

To safeguard against igniting the film in this way, a fire shutter should be installed that will automatically close the projecting aperture as soon as the machine comes to a stop. The approved type of shutter is attached in such a manner that it is controlled by the speed of the motor or crank. This device is simple in construction and the greater safety insured by its use will warrant the expense of equipping every machine with it.

FILM SHIELDS.

Additional protection against fire is insured when the upper and lower film magazines are entirely enclosed with metal coverings. The magazines should be equipped with film valves which will not permit the entrance of fire to the bulk of the film, in case some part of it becomes ignited during its passage through the machine head.

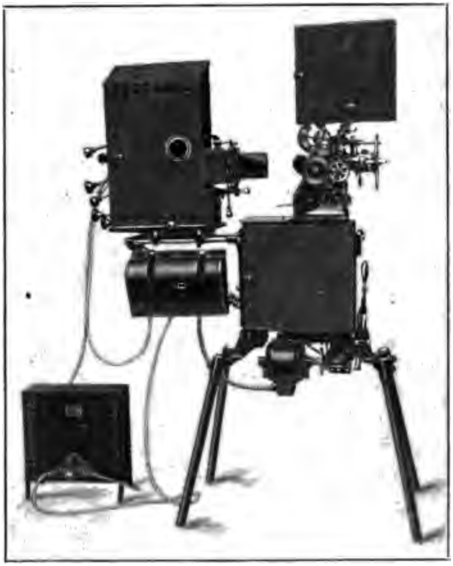


FIG. 6. A MOTOR-DRIVEN MACHINE, SHOWING VARIOUS PROTECTIVE DEVICES.

STORAGE MAGAZINES.

All storage magazines should be built of heavy-guage galvanized iron, with inside partitions arranged so that no more than six reels of films can be stored in any one compartment. No solder should be used in the construction of these magazines. Riveted joints are far safer and more serviceable.

ARC-LIGHT PROTECTION.

The housing for the arc lamp should be constructed of heavy sheet metal, lined with asbestos or mica to prevent short-circuiting in case the carbons come in contact with the sides of the housing. On each side of the enclosure there should be a hinged door with a ruby light in the center, so that the operator can see the arc without opening the door. The doors afford access to the light, in case the operator has to trim the carbons or make adjustments to the rack and pinion device.

MISCELLANEOUS PRECAUTIONS.

The film should be conveyed through a covered channel, wherever the operation of the sprockets and gearing does not interfere, being exposed only at the projecting aperture, and while in motion.

A mat of rubber or linoleum should be placed on the floor around the machine, so that the operator must stand upon it when making adjustments to the machine.

All rheostats and switches that are located on the machines should be covered by sheet-metal or wire-mesh guards.

Double-throw switches should not be mounted so that the handle moves downward when *closing* the switch, because a switch that operates in this way may be closed accidentally by the falling of the handle. The better way is to have the switch mounted so that the handle moves in a horizontal direction.

The circuit for the arc light should be open and the doors closed while the film is being removed from the magazine to be placed on the bench reel for rewinding.

The most convenient way for the manager and operator to work in harmony is to have a telephone connection between the operating booth and the manager's office. By this arrangement a large amount of unnecessary inconvenience will be eliminated. A call bell is unsatisfactory for this purpose.

The auditorium should never be entirely dark. Local ordinances usually require a low degree of diffused illumination; and the illumination should be provided even when there is no such ordinance, because a person entering a dimly lighted room from a strongly lighted street cannot see distinctly lighted room from a strongly lighted street cannot see distinctly until the eyes have become accustomed to the new conditions.

We also recommend that a placard be posted at the entrance requesting patrons to stand at the rear of the auditorium for a few moments before going to their seats, so that their eyes may become accustomed to the faint light. This helps to avoid accidents from stumbling and from colliding with fixed objects or with other persons.

ELECTRICAL EQUIPMENT.

As a rule, electric power companies do not supply current at a potential lower than 110 or 220 volts. Theater proprietors should ascertain the voltage of the current that is supplied by the local company, so that the electrical equipment may be properly adjusted and connected at the outset.

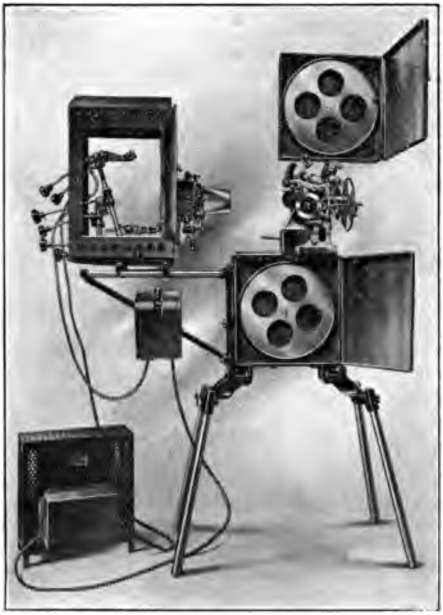


FIG. 7. A WELL-EQUIPPED MACHINE, WITH ACCESSORIES.

There has been considerable discussion regarding the relative merits of alternating and direct current for the arc light used to project the pictures. In an arc lamp using direct current the greatest amount of light comes from the crater of the positive carbon. When the alternating current is used there are two craters—one for each carbon, as they alternately change from positive to negative—and each of these craters is smaller than the one produced by a direct current of the same amperage. The direct current gives a soft light on the screen, while the light produced by the alternating current is somewhat harsher, and it is apt to flicker when it is generated at a frequency of less than 40 cycles per second.

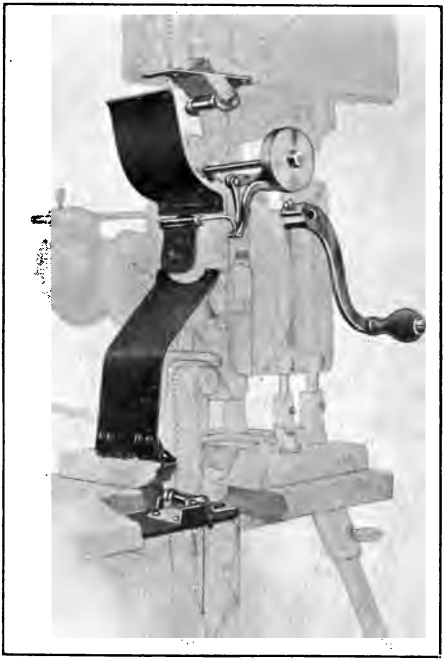


FIG. 8. AN AUTOMATIC FIRE SHUTTER, ADAPTABLE TO HAND-OPERATED MACHINE.

(The mechanism is controlled by the pressure on the crank, and when this is relieved the shutter drops automatically, cutting off the condensed beam of light from the arc lamp.)

MERCURY-ARC RECTIFIER.

This is a device for transforming alternating current into direct current, and as usually constructed it has a capacity of from 30 to 50 amperes. Some attendants operate the device above its rated capacity, believing that this will produce a more brilliant light at the arc; but this is bad practice, and it affects the rectifier injuriously.

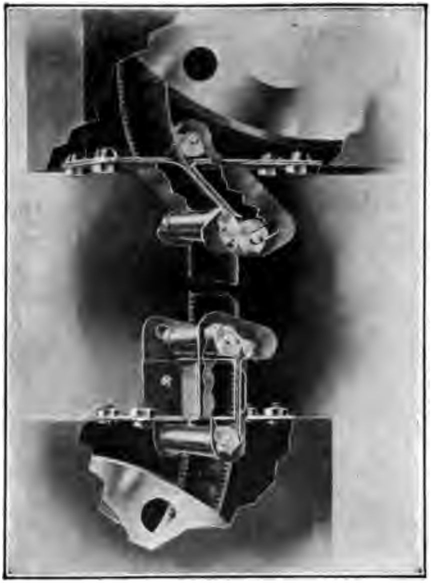


FIG. 9. ILLUSTRATING THE USE OF FILM VALVES ON THE UPPER AND LOWER MAGAZINES, TO PREVENT FIRE FROM REACHING THE BULK OF THE FILM ON THE REELS.

WIRING THE BOOTH.

Part of the circuit is subjected to considerable heat, this occurring principally at the arc and in the resistances. These points should receive ample protection. All wiring should be conveyed in metal conduits wherever practicable. The incandescent lights over the machines and benches should be protected by wire guards.

In many well-arranged houses the lights for the entire theater are controlled by switchboards in the operator's booths. These should be of an approved type, and they should be mounted on marble bases and have all their parts well insulated. It is also advisable to have them covered by enclosures provided with hinged doors having spring catches.

Careless operators sometimes bridge the terminals of fuses with copper wires after the regular fuses have burned out. This should not be permitted, but a supply of fuses should be kept on hand at all times for emergency purposes. Cartridge or plug fuses should be used in connection with switchboards, and those of the open type should be avoided.

RESISTANCE COILS.

The resistance coils (which are used for regulating the current supplied to the arc lamp) should be encased, and should be mounted on some sort of fireproof material that is properly insulated. The wiring should be such that the temperature will not exceed 400° Fahrenheit.

FILMS.

Standard-size films are 1⅜ inches wide and about two one-thousandths of an inch thick, and there are sixteen pictures to each foot of film. Along each edge there are 64 perforations (known as sprocket holes) to each foot of film, and the film in its travel through the machine head is impelled by sprocket wheels, the teeth of which engage in these holes. To obtain good results, the film should travel past the projecting aperture of the machine at the rate of about one foot per second. This means that there are sixteen pictures projected upon the screen every second.

There are various kinds of films on the market at present, but they may be divided into two classes, inflammable and non-inflammable. The former are usually made of "celluloid" or of nitrocellulose, and the non-inflammable ones are ordinarily made of aceto-cellulose, which is a compound of cellulose and acetic acid. The nitro-cellulose of which the inflammable films are commonly made contains so much oxygen that the material is not dependent upon access to the air for burning. Its combustion, once begun, is self-supporting, and will proceed in an air-tight magazine. Films of this kind will ignite at a temperature of about 330° Fahrenheit, under favorable conditions, and when ignited they burn with great rapidity, resembling certain grades of smokeless powder in this respect, as well as in their chemical constitution. Sand is the best substance for extinguishing fires of this kind.

Torn films are usually patched and otherwise repaired by the use of collodion or by a solution made by dissolving a few small pieces of the film in acetic ether. These solutions are highly combustible, and should be kept in glass bottles or in metal receptacles of some kind, as they give off inflammable vapors even at ordinary temperatures. They should also be kept as cool as possible.

At present, inflammable and non-inflammable films are both in use in nearly all theaters, because the exchanges through which the films are obtained stock both varieties, and when a certain picture is desired the necessary films are shipped regardless of their combustible qualities. Owing to the fact that the two kinds of films can be used interchangeably in the same machines, all possible precautions should be taken to prevent

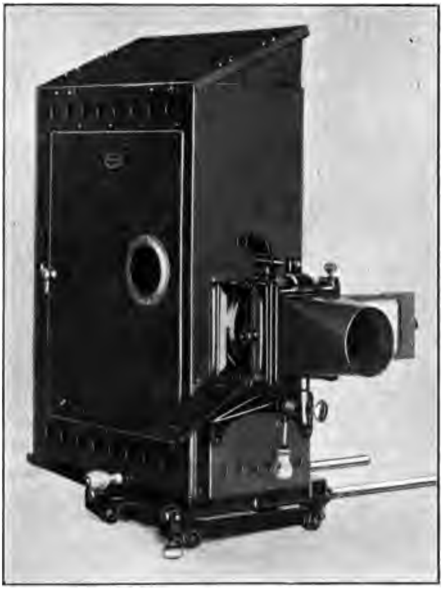


FIG. 10. A WELL-VENTILATED LAMP HOUSE, WITH SLIDING WAYS TO PERMIT FORWARD AND LATERAL ADJUSTMENT.

(The "douser" is operated by a handle in front.)

fires, even when it is the intention to use non-inflammable films as much as possible.

OPERATORS.

However rigid the requirements may be in regard to the proper protection of the machine and its equipment, many accidents resulting in fires and panics may occur if competent operators are not employed. The patrons of the theater know little or nothing of the dangers that are involved, and must rely upon the competence and good judgment of the operator for their safety. An operator should have a knowledge of electricity sufficient not only to enable him to operate his machine intelligently, but also to make necessary repairs in case of an emergency. In many localities operators are required to pass examinations to test their ability to operate the electrical apparatus used in connection with the projecting machines, receiving licenses if they are found to be competent.

INSTRUCTION OF EMPLOYEES.

All employees should be thoroughly instructed with regard to their duties before being permitted to begin work. They should also learn the locations and methods of manipulating the fire extinguishers and hose connections, and the nearest fire-alarm boxes; and they should become familiar with all of the emergency exits, fire escapes, and other protective devices throughout the building. Instruction should also be given them as to the best methods of dismissing audiences in case of fire or impending panic, so that the theater may be emptied quickly and in an orderly manner.

CO-OPERATION WITH INSPECTORS AND WITH THE FIRE DEPARTMENT.

In many cases a member of the local fire department is stationed in the theater during each performance, and the fire department is also ready to co-operate with the theater management in other ways. It is advisable, whenever possible, to have the theater inspected at regular intervals by persons trained in modern methods of fire prevention, because such inspections often disclose dangerous conditions, the existence or importance of which may not be apparent to persons who are not skilled in this work. Chemical fire extinguishers become valueless if the contents are not renewed periodically; hose deteriorates in time and becomes worthless; hose nozzles are lost or become misplaced; and exits and fire escapes are often allowed to become obstructed or covered with snow and ice. These and many other similar conditions may escape the attention of the owners, operators and employees of the theater, but they will be discovered by expert inspectors, and the cost of this service will be outweighed by the additional security afforded both to the theater owners and to the public.

REINFORCED CONCRETE CONSTRUCTION.

Principles and Practices of the Use of Concrete in Building Construction. Prize Essay Before Insurance Institute.

By S. Broadhurst, Manchester, England.

To those members of the fire insurance profession who have not made a special study of this class of construction a short paper thereon will, I think, be of interest, particularly in view of the abnormal development of such construction during recent years (which, I feel sure, will be more pronounced in the near future) and its application to many large public, commercial and industrial buildings.

It is not my intention in this paper to give a highly technical disquisition and consequently, to most of the members of the Institute at least, a confusing and uninspiring one upon reinforced concrete construction, my object being more modest, that is, to give in as concise and non-technical a manner a few particulars concerning the principles governing this system of construction.

THE SAVING IN COST AND UPKEEP

of a building erected on such a system over a building constructed of any other class of massive materials is a considerable amount (being, I understand. at least 20 per cent. on the first cost and from 80 to 90 per cent. on the upkeep), and the erection of many future buildings of reinforced concrete may, I am sure, be foreshadowed without any risk of ultimate developments proving it a false prophecy.

The term "Reinforced Concrete" means a combination of concrete and steel, the steel disposed in such a way as to resist stresses which the concrete alone would be unable to resist, except to a very mild degree. This fact I will endeavor to make clearer a little later on when consideration is being given to the stresses which are acting in a beam or column.

For the inception of reinforced concrete construction England was chiefly responsible,

THE EARLIEST PATENT

being dated 1854, but the system remained practically dormant in this country until the last few years, although it was very extensively adopted abroad, particularly in America.

The reason for this may be that at first the designers and engineers of this method were more daring than scientific, that no reliable data was obtainable, and that calculations of stresses and loads were empirical.

This period is now, however, consigned to the limbo of the past, and may, I think, be considered as extinct as the dodo, the investigations and tests of many engineers and architects who have specialized, both at home and abroad, during the past ten years, having resulted in a scientific method of calculation being determined, which found official expression in the formation of rules and standard specification by the Joint Committee on Reinforced Concrete appointed by the Royal Institute of British Architects in 1907, to which designers and engineers now generally conform.

THE PRIMARY PRINCIPLE

of reinforced concrete construction in the case of a load bearing beam is to employ the concrete to resist compressive stresses (for which purpose it is adequate) and to employ the steel to resist the tensile stresses, for which the concrete in itself is comparatively incapable.

The term compressive stress is self-explanatory, and the term tensile stress means that stress caused by direct tension or pull.

In addition, these stresses induce shear stresses which introduce into a beam uniformly loaded a shear or slicing towards its abutments or supports.

It is essential that all these stresses must be adequately considered in the design of a reinforced concrete beam.

In the case of a column the compressive stresses are taken by the concrete as in a beam, and the steel is to prevent the column buckling or bending.

THE CONCRETE USED

should be of good quality, and the aggregate used should be clean, hard material. Granite forms the strongest concrete from a structural point of view, but is expensive, and, in addition, is liable to crumble under the stress of a severe fire. Stone, gravel or broken brick is generally used, but of the three, brick forms by far the best fire-resisting material, although the same is not so strong as either stone or grave' for load bearing. Coke breeze or boiler ashes should not be used, as being too soft a material, and also the danger of sulphur being present, which would corrode the steel. The aggregate should be in cube form, varying in size between ½ and ¾ inch, and not in flakes, as in the latter case there is a danger of the cement not getting between the layers, and thus a homogeneous whole is not formed.

The sand used should be clean, hard and gritty, having large particles, and be free from loam or other earthy matter.

The cement should be slow-setting Portland of British manufacture, and should comply with the British standard specification (revised June, 1907), which requires a certain gravity, fineness and tensile strength.

THE STEEL.

The once prevalent idea that any iron or steel, however inferior, might be used for reinforcing concrete has long since disappeared, and it is generally considered that a mild steel having an ultimate tensile strength of about 60,000 lbs. to the square inch should be used. High carbon or hard steel should not be used except under certain circumstances and conditions.

In the erection of a reinforced concrete building centering or timber supports are used as molds for the concrete, and it is necessary that no shavings, chippings or other refuse should be in the molds, as the introduction of any foreign matter into a beam or column would have a weakening effect, and it is well to closely observe the main structural members when surveying a risk of this construction for such flaws.

In the case of a beam the best form of reinforcement is that which has rods running near the base and has members securely and rigidly attached running into the concrete towards the top. These members, known as shear members, are intended to take all shear stresses, and are best when inclined at an angle of about 45 degrees, but they will do their work quite well if vertical, provided they are well designed and are securely attached to horizontal bars near the top of the beam.

IN THE EARLY DAYS

it was thought that merely embedding steel bars in the bottom of a concrete beam to take the tension stresses was sufficient. In practice, however, this method proved inefficient, in addition to being a waste of steel owing to the horizontal reinforcement having to be of very large size bars to enable it to take all stresses other than compressive.

The next form of reinforcement used consisted of horizontal bars having loose shear members or stirrups extending from the base to the top of the beam, but in no way attached to the main horizontal reinforcement.

This method also proved unsatisfactory owing to the slipping of the bars when the beam was under load and the moving out of place of the shear members during the ramming of the concrete.

This state of affairs brought about the introduction of the stirrups, or shear members, being securely attached to the main horizontal reinforcement by welding, rivetting or keying in such a way that they would break before pulling loose. Wrapping the stirrups round the bars, either hot or cold, is not sufficient, as the connection must be such that they become an integral part of the main bars.

IN THE CONSTRUCTION OF COLUMNS

the main reinforcement is by vertical steel bars, and these should be spaced and rigidly held in position by links or spiral binding to assist against any tendency on the part of the column to buckle and also to prevent the main bars slipping during the ramming of the concrete. It is also advisable to have cross links running through the center of the column from main bars to main bar to reinforce the core, and excellent results have been obtained from columns so reinforced.

In the erection the reinforcement of the beam should run over the reinforcement of the column, and to my mind it is preferable to have the two reinforcements secured together to prevent any tendency to slip, but this is not essential, as it very often is sufficient to turn up or fish-tail the ends of the beam bars to provide the grip necessary to prevent such tendency.

It might be as well to note here that a reinforced concrete building during its erection is subject to the human element and to the mistakes and errors consequent upon the use of comparatively unintelligent labor than a building of any other class. A wrong mixture of concrete, the deviation, even in a slight degree, from the plans for the spacing and erection of the reinforcement or the throwing out of alignment of the same during the ramming of the concrete would introduce weaknesses into the structure, and on this account, and also to provide against abnormal loads. it has been the practice of British architects to specify a factor of safety of 4 to 6, *i.e.*, to design the beams and columns to resist from four to six times the normal load to be borne. How long this practice will be in force is open to conjecture, considering that abroad such degree of precaution is not general and the extra cost entailed.

The foregoing also emphasises the fact that all buildings erected should be under the supervision of a competent engineer, architect or clerk of works.

THE FIRE PROTECTION OF STRUCTURAL MEMBERS.

After this brief description of the principles and practice of reinforced concrete construction, which in view of the space at my disposal must of necessity be of a somewhat feeble and disjointed effort, a few remarks on the protection against fire of the main structural members will not be out of place.

It is a well-known fact that concrete, when subjected to intense heat of about 1,000 degrees Fahrenheit or over, for a continuous period will lose a part of the water taken up in crystallization. This is known as dehydration, and when dehydration is complete the strength of the concrete is destroyed.

Dehydration, however, is a very slow process, and will, even in the most severe fire, only extend to the depth of one inch of the concrete, although cracks may extend further. Dehydrated material, being a poor conductor of heat and generally remaining in place for some time at least, it protects the mass of concrete from further dehydration.

It is not good practice, as a general proposition, to use the same material for structural duty and for resisting fire. The fire alone will give stresses enough for the material to resist without having to resist any structural load.

If the quantity of concrete on the outside of a reinforced column or beam is increased so as to allow a loss of the material during a fire without affecting the load bearing quality of the structural member, the additional material added for fire resisting will participate in the load carrying, in spite of all that is done, and this would render it less able to resist a fire.

Furthermore, should the fire be so severe as to cause dehydration, cracks may extend beyond the dehydrated portion to the steel reinforcement, with obvious results, owing to the column or beam covering being an homogeneous material.

THE IDEAL WAY TO PROTECT A STRUCTURAL MEMBER

would be to construct that member as a unit of sufficient strength to withstand all structural loads, and then to place the fire protective covering on separately. This would allow of dehydration without affecting the load bearing quality of the member, and, also, should cracks occur it is probable that they would not extend further than the covering owing to its separate construction.

For this reason, to ensure a first-class fire-resisting risk, a thickness of one inch of concrete on the outside of a structural member is, to my mind, sufficient for a separate fire protective covering for a reinforced member, while three inches should be regarded as necessary if the fireproofing is incorporated with the material for the column itself.

The above, however, should be regarded as a general statement, the covering necessary being dependent upon the class of trade for which the building is to be used and the likelihood or otherwise of a fire therein attaining a high temperature, and discretion should be used in specifying, whenever an opportunity occurs, which I think will not be very frequent under existing conditions, owing to the extra cost involved by separately protecting a reinforced member.

It is my personal opinion that the rules applicable to buildings of fire-resisting construction could, with advantage, be revised and extended, as also could the discounts allowed, particularly in regard to buildings of reinforced concrete construction.

APPLE EVAPORATORS.

A Careful Description of the Processes, Machinery and Buildings Used in the Production of Evaporated Apples—Fire Hazards—Suggestions.

By S. H. Billinge, Inspector, New York.

The fruit evaporator as a fire risk is a class by itself. There is no other risk or class to which it can be compared, or is it related in its hazards to any of the many manufacturing plants that abound. They grade from the small family or cookstove evaporator on the farm, for individual or household use, to the large commercial evaporator, wherein the business as conducted is the supplying to domestic and foreign markets evaporated apples, peaches and pears. In a general classification they would group about as follows:

Cookstove evaporators.
Portable outdoor evaporators.
Tower evaporators.
Kiln evaporators.
Dehydrators.

Dehydrators are listed here only because they are related to evaporators, but as the process is somewhat different, they properly are in a class by themselves, and these will be touched upon here only incidentally. There is still on sale fruit dried by primitive methods. A large flat rock, the roof of some low shed, or other flat surface is selected, upon which apples sliced or quartered are placed for drying in the sun. In some sections "strings" of quartered apples hanging by a doorway to dry or behind a kitchen stove are still familiar sights. This fruit is commonly referred to as "dried apples" in distinction from that produced in evaporators, which is known as "evaporated apples." The average weight of ripe winter apples of mixed varieties is about 50 pounds to the

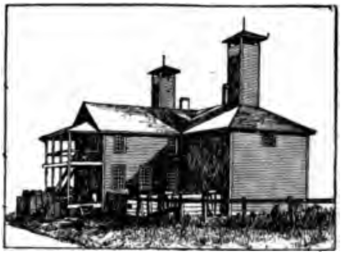


FIG. I
EXTERIOR OF TWO-KILN TOWER EVAPORATOR.

bushel. In evaporating them about 40 pounds of water per bushel, or approximately 5 gallons, passes off in the form of vapor. The evaporating of apples may be said, in brief, to consist of driving off as rapidly as possible, by means of artificial heat, enough of their moisture to prevent deterioration through decay or other natural processes which occur in fresh fruit, and at the same time to retain a desirable texture and flavor.

THE PROCESS EMPLOYED

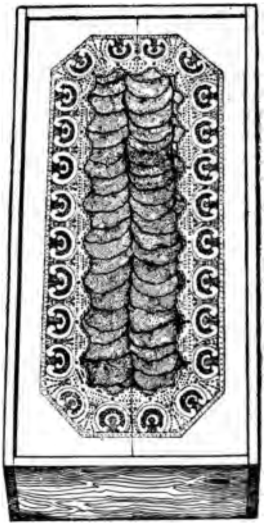
in producing evaporated apples is briefly as follows: The apples are conveniently stored in bins, and from there conveyed to the paring table, by an endless conveyor or by hand; they are there pared, cored and trimmed and dropped into a conveyor, which carries them to the bleacher. This process has to be quickly performed, as the fruit rapidly darkens when exposed to the air. The pared and cored apples are then placed in the bleacher, into which sulphur fumes are fed, the vapor bleaching or whitening the pared fruit, thus insuring clean white stock. The old-fashioned dried apples, sun or air dried, are dark brown in color and are cut into quarters instead of being white and thinly sliced as are the evaporated apples. The bleaching process occupies from one-half to one hour, depending upon the kind or character of the fruit in process. When bleached they are delivered by hand or power to the slicing machines, which quickly slice the pared, cored and bleached fruit into thin slices. They are then carefully carried to the dry room or kiln for the final process of drying before packing. Included under the trade name of "waste and chops" are the cores and parings and the small apples that by measure test are found to be not large enough to evaporate. This waste is conveyed to a chopper, and when the kiln is not in use for drying the regular stock, the waste is then dried; for even this waste now has a commercial value and a market where formerly it was discarded.

A complete description of the small cookstove evaporator and the portable evaporator on the farm will not be attempted here, as the commercial evaporator, being more complete in construction and equipment, is better adapted to serve the purpose of this article. The cookstove variety is a small box-like structure, usually made of sheet iron, which can be placed on top of an ordinary cookstove, size and arrangement depending upon the apple supply. The portable outdoor evaporators are convenient when it is desired to dry only a small lot of fruit at one time, their capacity ranging from five to ten bushels a day. They are usually built of wood, but other styles built of sheet iron galvanized are obtainable from dealers in evaporator machinery. These are in use principally for home and local market consumption.

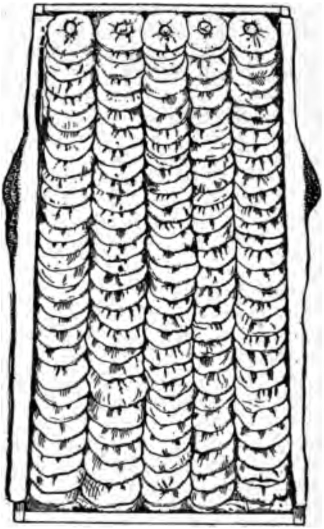
Some attempts have been made by farmers with an ambition, but not the means, to own a fully equipped plant, to reconstruct an old barn or outhouse, placing therein a large cast-iron stove with a maximum of heat radiation. A crude attempt is made at kiln floor slatting, and according to the ingenuity of the farmer, there is constructed a device for carrying and distributing the sulphur fumes.

These houses burn principally because of faulty construction, physical and not moral hazard being responsible.

Of the large commercial evaporators, the type known as the tower evaporator is rapidly giving place to the kiln variety, so that at the present time comparatively few of the former are in use. As the name implies, a tower is its chief characteristic. Of these towers there may be one or more, depending upon capacity and building area, for there is no more definitely prescribed manner in which they shall be constructed than there is governing the construction of a kiln evaporator. The tower



50-POUND BOX OF "FANCY" EVAPORATED APPLES WITH COVER REMOVED.



50-POUND BOX OF "FANCY" EVAPORATED APPLES WITH COVER AND PAPER LACE REMOVED.

in a way resembles a chimney or an elongated elevator on the roof. Only heat passes through it, a separate flue being provided for the smoke from the furnace. If there are several towers, they may be disconnected or they may be built side by side, or back to back, and entirely within the building, except such portion as extends above the roof. They are built both of brick and frame. Another method is to build them entirely on the exterior, opening into the interior, similar to an outside chimney. Heat ascends from a furnace at the bottom of the tower. As this type of evaporator is so rapidly giving place to the more modern kiln type, a description of the working plans is not required. The superseding of the tower evaporator by the kiln variety is due largely to the reduced cost of maintenance, better results from the kiln floors as compared to tower trays or racks, resulting, perhaps, from the fact that in the construction of these racks where galvanized iron wire of about one-quarter inch mesh is used as the foundation flooring, it was found that the chemical action of the acid from the fruit upon the coating of the wire caused a discoloration in the fruit that influenced the sale and the price. Fig. 1 shows a two-furnace tower evaporator.

THE MODERN COMMERCIAL EVAPORATOR

is of the kiln type, and of their merits a more complete description will be given, first listing the appliances that go to make up the equipment of both tower and kiln evaporators. The furnace (if of the tower type), the furnace and the kiln (if of the kiln type), the steam plant (if drying is done by steam pipe radiation, as in dehydrators), the paring table, paring and coring machines, sulphur bleacher, kiln floor and the fruit press. Other than the furnace, the kiln, the bleacher and the kiln floor, no lengthy description is necessary for the purpose of this article. In evaporators, both brick and frame, built in recent years and designed for the purpose, the fire hazard being known and recognized, construction has therefore been along lines with a view to the elimination of this feature as far as possible, but in the best of them this hazard is ever present.

KILN EVAPORATORS.

While the principles of construction of the different evaporators of this type are similar in all cases, the details and the arrangement of the appliances vary.. The general features of the exterior are seen in Fig. 2, showing a large brick evaporator, where the paring shed and bleachers are on the outside of the kiln building. In most of the evaporators the entire process, including the paring and bleaching, is done within the building. A conveniently arranged one-kiln evaporator is shown in Fig. 3, the plan of the first floor in Fig. 4. The space is divided into a furnace room about 14 x 16 feet, and a room somewhat smaller in which the apples are pared. An upright bleacher, which also serves as an elevator for raising the fruit to the second floor, is placed in this room. The second floor is divided in a similar way. The kiln has the same dimensions as the furnace room, with a capacity of 75 to 100 bushels of fruit at each filling. The workroom on this floor contains the slicer and the upper portion of the bleacher. The fruit as it is taken from the kiln can be held here temporarily. If the evaporator is a frame building, the walls of the furnace room, to insure safety, should be plastered or covered with asbestos paper, as the danger from fire is thereby lessened because of the intense heat generated.

THE FURNACE.

Care should be taken to place the furnace in the center of the furnace room, both for proper radiation and thereby insuring equal distance from the woodwork on all sides. It should be placed upon a dirt or cement floor with a sufficiently large ash pit. The radiating hot air pipes from the top of the furnace are placed at a slant, thereby giving a maximum heat. The distance of these hot-air pipes from the kiln floor depends upon the area covered, but in no case must they be too close, as on

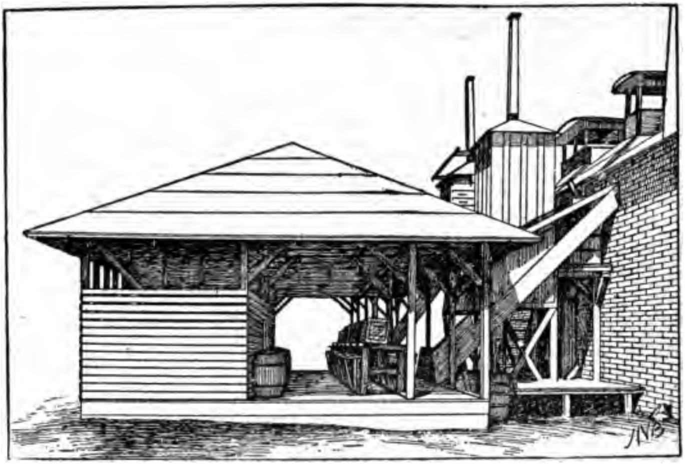


FIG. 2
PARING SHED AND BLEACHERS OF BRICK KILN EVAPORATOR.

account of the intense heat thrown off danger from fire is a likely result and the process of evaporation is likely to result in failure. Proper ventilation well guarded must be provided in plenty, both as a preventative against fire and to insure good results in evaporation.

THE KILN

consists of a floor made of slats and placed over the furnace room. Such floors are generally made of poplar, bass wood or maple strips about seven-eighths of an inch thick, one inch wide on the top surface and one-half inch wide on the under side. These strips are placed one-eighth to one-fourth inch apart on the upper surface. This makes the space between them wider on the under side, this arrangement allowing the small particles of fruit which work down between them to drop through without clogging. Reference to Fig 5 will show the method of constructing the floor of the evaporating kiln. The continued use of the kiln floor without occasional cleaning, will result in the fruit sticking to the floor. To prevent this the practise of oiling the upper side of the slats is resorted to. This is hazardous from a fire safety viewpoint, and it has a tendency to discolor the fruit. The waste and chops kiln is smaller and separate, and it is at this point that a

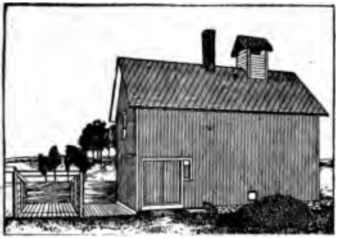


FIG. 3
ONE-KILN EVAPORATOR, WITH ADJOINING APPLE BINS.

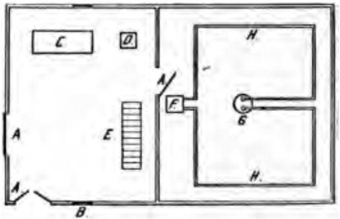


FIG. 4
FIRST-FLOOR PLAN: A, DOORS; B, WINDOWS; C, PARING TABLE; D, BLEACHER; E, STAIRS; F, CHIMNEY; G, FURNACE; H, PIPES.

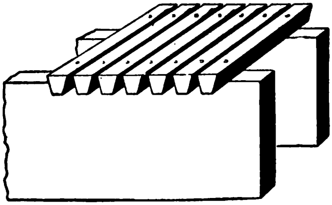


FIG. 5
SECTION OF A KILN FLOOR, SHOWING METHOD OF CONSTRUCTION.

source of danger is constantly growing, as the waste accumulates. The heating pipes here should be further away from the floor than they are under the evaporating kiln. The reason is obvious.

THE BLEACHER.

In order to make the fruit as white as possible, it is subjected, as stated, to the fumes of burning sulphur, and the best place for the bleacher is just under the roof on the second floor, and when placed here precautions must be taken to see that the fire hazard is safeguarded. The form and manner of construction vary greatly, but the one requisite is a perfectly tight compartment having a capacity commensurate with the size of the evaporator. The average bleacher consists of an oblong wooden box measuring about 24 inches in width to about 30 inches in height on the inside. The pared apples remain in the bleacher for about thirty to forty-five minutes, depending upon the texture of the fruit. The apples ride on slats on an endless chain run over sprockets at the head and foot of the bleacher. Various arrangements are resorted to in the construction and building of the fire pot to hold the burning sulphur and in carrying the fumes to the bleacher. The better types are made of all metal, although some are built of wood, metal lined. This kind is not recommended for obvious reasons, as by deterioration or a break in the metal, fire is apt to ensue, besides the danger of allowing the fumes to escape where not wanted, causing waste. Fig. 6 will show the average horizontal power bleacher.

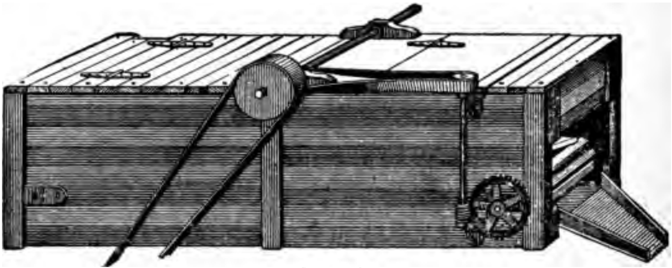


FIG. 6
HORIZONTAL POWER BLEACHER.

Space will not permit of a more extended description of the machinery in an evaporator, and as this article is from the viewpoint of a fruit evaporator as a fire hazard, a few

SUGGESTIONS

will be of interest to the evaporator owner having an earnest desire to safeguard his building against fire. The fruit evaporating industry, although in operation but a few months of the year, is nevertheless hazardous during the short season as is attested by the many fires which have taken place in fruit evaporators. While the losses have been many, after looking over a number of good and bad risks of the class, I am inclined to attribute the causes to faulty construction of building or equipment, or both, and gross carelessness in management, rather than to the feature of moral hazard which doubtless in many cases has been charged. The season of evaporation, which generally speaking is from late September to January, is the time when the evaporator owner and his helpers must be wide awake and on their guard. Where the furnace room portion of the building is not brick or cement, or if frame, not thoroughly lined with asbestos paper, the owner should, before the season opens, spray the inside of the building adjacent to the furnace, the joists and the under side of the kiln floors with whitewash made of lime mixed with a strong solution of salt water. Care should be taken that between the slats on the kiln floor and around the four sides of the floor, where air spaces are allowed between the floor and the walls of the building, all dry particles of waste or chops from previous season are carefully removed.

Every inch of the sulphur fire pot should be examined for cracks and crevices that will permit of burning sulphur sputtering out upon the floor or the adjacent woodwork. A sufficient number of fire extinguishers, either of the portable chemical kind or hand grenades, should be installed. When the season opens, men who are not addicted to drink should be employed, especially during the night watches; permit no smoking, particularly in the neighborhood of the dry chops and waste. If objection is raised against the chemical extinguisher, the alternative is a number of water barrels and fire pails. Have at least two well filled barrels near the waste kiln where there must be plenty of ventilation as well. Finally, do not allow any one to indulge in the bad practice, prevalent in some evaporators, of lighting sulphur upon a shovel in carrying it from one sulphur pot to another (where more than one bleacher is in use), in order to save time in starting the sulphur burning within the fire pot.

USE OF CELLULOID IN SHOE FACTORIES.*

Substitution of Pyroxylin Plastic for Leather in Counters and Box Toes—Processes and Hazards.

By (a) E. H. Bartlett and (b) H. P. Bruce, Inspectors,
Underwriters' Bureau of New England.

(a) CELLULOID BOX TOES AND COUNTERS.

Of late many shoe manufacturers have been using pyroxylin plastic, generally known as celluloid, on an extensive scale. The celluloid is used in the shoes, both in the form of counters and box toes. The use of these counters introduces no great increase of the fire hazard, but the use of celluloid in making box toes increases the ordinary shoe shop hazard materially.

COUNTERS.

In the celluloid counter the celluloid is reinforced on the outside by a small piece of sole leather to give stiffness, and then the whole is covered by a single piece of thin sheepskin covering both sides of the counter, and completely covering and concealing the celluloid. This method of making counters was invented and patented by Mr. G. H. Preble of Lynn, Mass., who sold the manufacturing rights to a Haverhill concern on a royalty basis.

The cost of these counters at present is the same as that of the highest grade of sole leather counters, so that there is no money saved by their use, and their introduction on a large scale in shoe factories is unlikely. Some manufacturers are using them exclusively in all their pumps and oxfords, as they claim that they are entirely proof against the softening effects of perspiration. These celluloid counters come from Haverhill, being brought ready made, and as the celluloid is completely covered by leather, they present practically no fire hazard.

BOX TOES.

The use of celluloid in box toes is a matter of no small importance. The celluloid is bought in sheets measuring 20 x 50 inches and 15-1000 inch in thickness, weighing about one pound to the sheet, and comes well crated in strong wooden boxes. The following description covers the conditions found in one factory, which probably represents the typical method of using the celluloid. The cutting of tips or boxes from the celluloid sheets is done in the cutting room, where the boxes are cut in lots of 2,000 pairs and tied into bundles of 100 pairs each. The lasters of this factory work in "gangs" of three men each, each "gang" having at his bench a supply of five different sizes of boxes. As there are ten "gangs," and as each hundred pair bundle weighs about a pound and a quarter, it follows that there is 60-65 pounds of celluloid on the lasters' benches at one time.

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*Reprinted from N. F. P. A. Quarterly.

There was also a main supply of celluloid in the lasting room in the form of 100 pair bundles, contained in five half-bushel boxes, and which would possibly amount altogether to 100 pounds or more, making the total amount in the lasting room 160-165 pounds.

Before the celluloid boxes are used it is necessary to soften them by immersing in a solvent. Originally wood alcohol was used for this purpose, but on account of objections made by the men, some factories gave it up and are at present using a mixture consisting of about 70 per cent. of denatured alcohol and 30 per cent. of acetone, to which is added ¼ to ½ per cent. of oil of citronella, the latter ingredient being introduced only for the purpose of improving the odor of the mixture. This liquid is used from open tin boxes holding one quart each. The celluloid tips are suspended in this liquid for a few minutes by special hangers, after which they are inserted in the shoe, which is immediately lasted. The lasting is done cold.

It is not possible to use this process on turn shoes, but it is said to be a great success on welt and McKay shoes. It produces a toe easily lasted, which is light, flexible, uniform and perspiration-proof.

The process is said to have been invented by F. H. Thompson and F. H. Preble, of Lynn, Mass. On account of the opposition of the labor union, the process is not being used in many factories, but the inventors expect that it will come into general use as soon as some arrangement can be made with the unions. Celluloid "boxes" are being cut and sold at the present time by the Preble Box Toe Co. of Lynn and shipped to various factories outside of Lynn.

SUGGESTIONS.

The introduction of the process should call for the disuse of gas on account of the increased hazard. Electric lights should be installed in its stead. Ventilators are needed to take off the fumes from the alcohol. The boxes containing the solvent should be kept covered when not in use.

The celluloid, both that at the workmen's benches and the main supply of cut stock, is not usually covered. The supply at the benches should be kept in deep tin boxes with hinged covers, these to be kept closed at all times when not in use. The main supply should be stored outside the factory in strong metal boxes or fireproof vaults, only that quantity necessary for the daily output being brought inside. This latter supply should be kept in tight metal boxes with self-closing covers. Not over 250 pounds of uncut stock should be allowed in main buildings.

These celluloid toe boxes are cheaper than the best grades of sole leather boxes, but are more expensive than the cheaper kinds used in low grades of shoes. From all that can be learned, it seems probable that this process will before long be used extensively by makers of high-grade shoes.

(b) CELLULOID-COVERED WOOD HEELS.

The wood heel industry has taken such rapid strides in the last few years that it now plays a most important part in the shoe industry, especially in the manufacture of ladies' shoes.

The principal advantage of the wood heel over the leather heel is that while it is very difficult to fasten the lifts on some shapes of leather heels, it is a simple matter to obtain any shape desired from a block of wood.

Shoe factories using wood heels can be divided into three classes:

(1) Those making the complete heel. This class includes some of the largest factories.

(2) Those buying the wood heel and doing the covering themselves.

(3) Those buying the covered heel already made, as in the smaller factory.

The first class includes factories making the complete heel and covering it.

The wood with which these heels are made is almost always of maple. This wood is bought in planks and sawed into strips wide enough for the desired heel model, the strips being then sawed into pieces about two inches long. These blocks are then shaped on a molding machine to the desired size and shape. They are treated with a thin solution of lacquer and are then ready for the celluloid coating.

This celluloid, which is a very cheap grade, comes in sheets about 20 x 50 inches and from 10-1000 to 15-1000 inch thick, a sheet weighing about nine ounces. From four to six of these sheets are fastened together and are cut with dies to the desired shape for covering the heels. Covers for about three pairs can be cut to the square foot. Some concerns cut up a day's supply, while others cut them as needed. The covers are sent to the cementing room to be softened and applied.

In some systems the absorber and the exchanger are arranged similar to the double pipe condenser, the colder liquid passing through the inner pipe and the warmer liquid through the annular space between the inner pipe and the inner surface of the larger pipe.

As the temperature of the cooling or condensing waters used in the absorption system differs, the same water is frequently used throughout. The cold water first assisting in liquefying the gas in the condenser, passes on to the absorber, where it assists in the absorption; it then passes through the weak liquor cooler and on to the rectifier, where water at a comparatively high temperature is required.

SOFTENING

is done in two ways: First by what is termed the cold process and second by the hot process.

The cold, or immersion process, consists of soaking the cover in a dish containing about a quart of solution made up mostly of wood alcohol with a small amount of acetone. The covers remain from one to six hours in this, and they are then plastic enough to stretch around the heel. The heel is held in what is known as a "Jack," which holds the heel on the top and bottom, the cover is stretched around the heel and cemented together at the breast with a heavy amyl acetate lacquer. The "Jack" is then removed and the cover is turned over the top and bottom of the heel, trimmed and cemented at the edges. The heel is now ready for finishing. A bottom lift of leather is fastened to the heel with a screw in the center, and with nails. The heel is then polished on a cloth buffing wheel with "Tripoli" polish, which gives it a smooth surface. The heel is now ready to be fastened to the shoe.

The hot or vapor process consists of softening the cover by means of the vapor given off when a mixture of wood alcohol and acetone is heated slightly. This heating is done in a wooden oven lined with hair felt and metal. The liquid is placed in a pan in the bottom of the oven, which is placed over a steam pipe. The covers are placed on a wire shelf above the liquid. The oven is tight except for the cover on top or door on the front for putting in and taking out the covers. The covers are allowed to remain in the vapor, the temperature of which is between 80 to 100 degrees Fahr., from four to five minutes.

These ovens are about 2 x 2 feet x 1 foot high and one operative has two ovens to attend. The cover or door to these ovens should have springs so as to close automatically and keep the vapor from escaping. From here on the process is the same as in the previous method.

The second class of risks includes those who buy wood heels and do the coating themselves. In this class the woodworking hazard is eliminated, but the celluloid hazard remains.

The third class of risks is those which purchase the wood heels already covered, and the hazard is only that due to the presence of the celluloid heels, which is small, as these heels will barely burn.

HAZARDS.

The woodworking hazard is the same as any woodworker, and a blower system should be connected to each machine to remove the sawdust and shavings to a good, safe shaving bin.

In cutting the celluloid there is a hazard in the celluloid and in the waste from it. Care should be taken to clean up all the scrap celluloid and have it removed from the building as soon as possible. There should not be more than 250 pounds of celluloid in the building at one time. The sheet celluloid and cut covers should be kept in a metal box with a metal cover when not in use and the main supply should be kept outside in a detached shed.

The main supply of liquids used as softeners should be stored outside and that in the dishes and ovens removed every night. The room in which this softening is done should be shut off in a good manner. There should be no open flames in the room, and if artificial light is used it should be incandescent electric with double globe, vapor-proof lamps with keyless sockets. The room should also be ventilated to the outside of the building.

RETOUCHING.

In most shoe factories a solution is used to retouch any damage done the uppers while the shoe is being made. Most of these solutions are made up of celluloid in solution with some solvent.

This solution is put on the damaged part with a brush, and after drying is buffed or rubbed up.

The retouching solutions come in small bottles holding about half a pint, and each operative may have from six to eight of these bottles on his bench.

Practically the only hazard in conducting this work is that of an open flame coming in contact with the gases given off.

SHOE FORMS.

Although this class of work will probably not be found in shoe shops, it is worthy of mention.

These shoe forms are used for show purposes, such as in salesmen samples and in shoes in store windows.

The forms are made of either light wood, fibreboard or pasteboard. The old way was to paint or stain them for a finish, and as the call was for a better finish, pyroxylin plastic was tried with good success.

There are two ways of coating the form with this. One is to cover the form with the sheet celluloid and the other to apply the coating by means of a spray. The first method, that of applying the sheet celluloid, is similar to that used in coating wood heels. The second, that of applying the coating by means of a spray, is much more hazardous.

In the risk visited the spray is applied as follows: The liquid, which is celluloid and acetone, is purchased in cans and is poured into the sprayer as needed. The container on these sprayers holds about one quart. The air pressure is supplied by an air pump.

The shoe form is held by a wire under a metal hood with a fan, which conducts the air and gas to the outside. One coat of this spray is given the form and it is then sanded down and two more coats applied. The finish is obtained by buffing as in wood heels. As the solution comes in any color, any shade can be matched. By this method a coating of celluloid about 10-1000 inch is obtained.

This process should be done in a well cut-off room, which is provided with suction fans to carry the vapors to the outside. No open flames should be allowed inside the room, and the light should be incandescent electric in double vaporproof globes with keyless sockets. The storage of the solution should be guarded as are other highly inflammable liquids.

CELLULOID FACTORY FIRE.

Description of Causes and Effects of a Fire in a Celluloid Factory.

From the N. F. P. A. Quarterly.

This fire occurred in a large plant manufacturing a pyroxylin plastic known as fibreloid, which is a patented trade name for an article commonly known as celluloid. Plant consists of twenty-five distinct sprinklered buildings, basement, one and two stories in height and mostly of mill construction. All buildings are well detached. Eighteen of them are comparatively of small size, while seven contain, in all, thirty-one distinct cut-off fire sections.

Sprinkler systems are supplied through suitable connections from an eight and ten inch yard loop having an eight-inch connection with a thirty-inch high service waterworks main, pressure 105 pounds. Secondary supply consists of a 1,000-gallon Underwriters steam fire pump.

The fire originated in the solvent building, a one story and basement brick building of mill construction, forty-two by forty-two feet area. This building was used for the recovery of camphor from scrap fibreloid and contained two machines especially designed for this purpose. This process consists of treating scrap with caustic soda and extracting the liberated celluloid. There was always more or less storage of scrap in wooden boxes packed on first floor and in basement. The first notification of fire came from the electric annunciator connected with alarm valves. Engineer promptly notified the fire department which started the pumps. Building was found to be burning fiercely, flames shooting high into the air, as is typical for this class of material. Two streams were taken from pump and the fire department also laid two streams. Attention was directed to the exposed buildings. Sprinklers in first story, about twenty in number, all opened but apparently had very little effect upon the fire, due to the extreme hazard of the contents. There were twenty-three sprinkler heads in the basement, only eleven of which opened. Very little fire took place in this basement, fire being most vigorous on the south side of the first floor where it appeared to have originated. Sprinklers in the other buildings materially aided in preventing fire from entering them.

Although there was no manifestation whatever of an explosion, three walls of the solvent building fell outward about half an hour after the start of the fire. The cause of this seems to have been the same which has been assigned to other fires of this character, namely, that the heat and gases from the combustion of a large quantity of this material will destroy brick or concrete work as the intense heat, quickly applied, causes unequal and excessive expansion, resulting in failure of the structure. This should be accepted as one of the characteristics of the combustion of large quantities of pyroxylin plastic materials.

The actual cause of the fire is impossible to determine, several theories being advanced, the most likely of which is that there was some foreign material contained in this scrap which may have started the fire.

CONCLUSIONS.

(1) In planning protections against this hazard, the great intensity of the fire over that of an ordinary fire should be thoroughly considered.

(2) The sprinkler equipment should be planned on the assumption that considerable of the water will be evaporated by the excessive heat.

(3) On account of the great amount of heat radiated from this burning celluloid, whether in a fireproof vault or not, it is imperative that it should be stored a distance of at least fifty feet from surrounding buildings.

(4) It is desirable to keep the amount of material subject to one fire to five tons or less. If large quantities must be kept on hand, they should be divided into small amounts and stored in separate fire sections, preferably separate buildings.

BREWERIES.

Description of Processes Used in Malting and Brewing—Products—Fire Hazards Pointed Out.

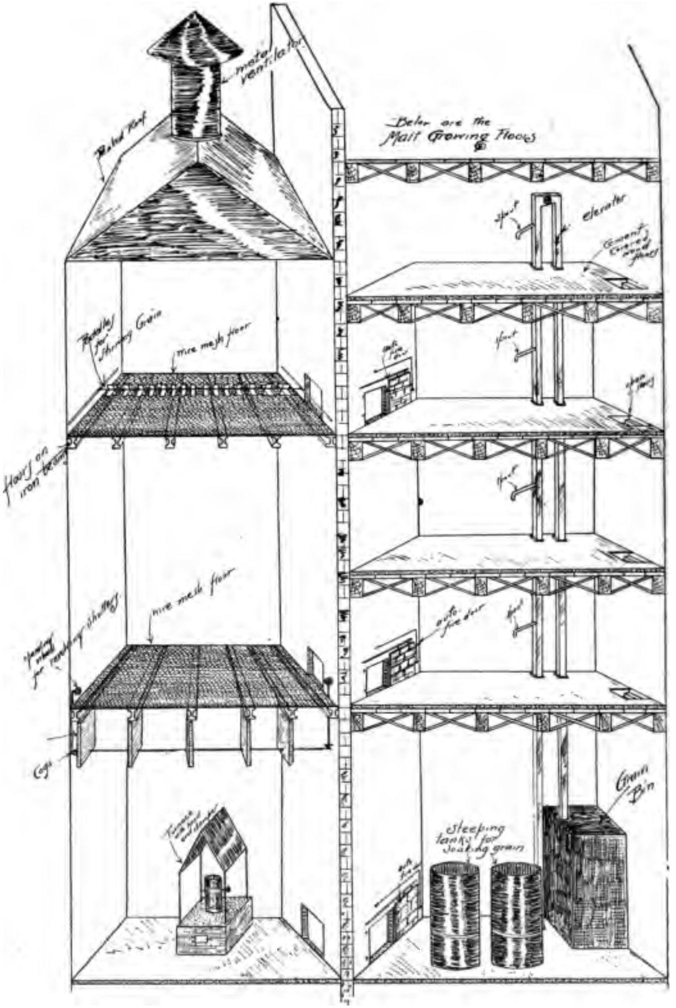
By Charles E. Jahne, Insurance Surveyor, New York City.

While it is usual to speak of the manufacturing of beer as brewing, and the place where it is made as a brewery, still there are two distinct processes to be considered in the manufacturing of beer, namely, malting and brewing.

The raw materials used in manufacturing beer are water, barley and hops, and there are often added to these, for the direct purpose of adulteration and ageing, the following, in proportionately small quantities and at different times: wormwood, aloes, Dextrine, malt sugar, yeast, picric acid, strychnine, resin and sodium bicarbonate.

The finished product should be allowed to be on storage in the kegs many months in order to age or prime before being used, but the use of different adulterants of the kind just named saves this long term of storage.

The first process to be considered is the malting or artificial germinating of the barley. The germinating house is usually seven or eight stories high, of ordinary wood-joist construction, wooden floors, covered with a flushing of cement; ceilings are usually low, stairs open, and exterior walls have numerous small windows, each having ventilated wooden shutters. The barley is first put into large vats, known as steeping tanks, and the grain is covered with clean, cold water. It is allowed to remain there about three days. This steeping process swells and softens the grain as it absorbs the water. When it has reached the proper consistency, it is carried by the lofters (which are iron cups on leather belting, in a narrow, wooden enclosure) to the growing floors (which are the cement-covered floors referred to in the note on construction). Here it is spread out over the floor to a depth of from twelve to eighteen inches, according to the texture of the grain, and with a moderate temperature it will germinate or put forth a sprout, which, if allowed to develop, would form a root or blade. The maltster watches this germinating process very faithfully, because on the result of this depends the success of the brew. The growing process consumes usually from ten to fifteen days. From the growing floors the grain passes to the kiln house. This is a


metal ventilator
Peaked Roof
Paddles for Stirring Grain
wire mesh floor
floors on iron beams
Below are the Malt Growing Floors
spout
elevator
Cement covered wood floors
auto fire door
spout
spout
auto fire door
spout
wire mesh floor
Cogs
Furnace with hood and damper
steeping tanks for soaking grains
Grain Bin
auto fire door

MALT HOUSE.

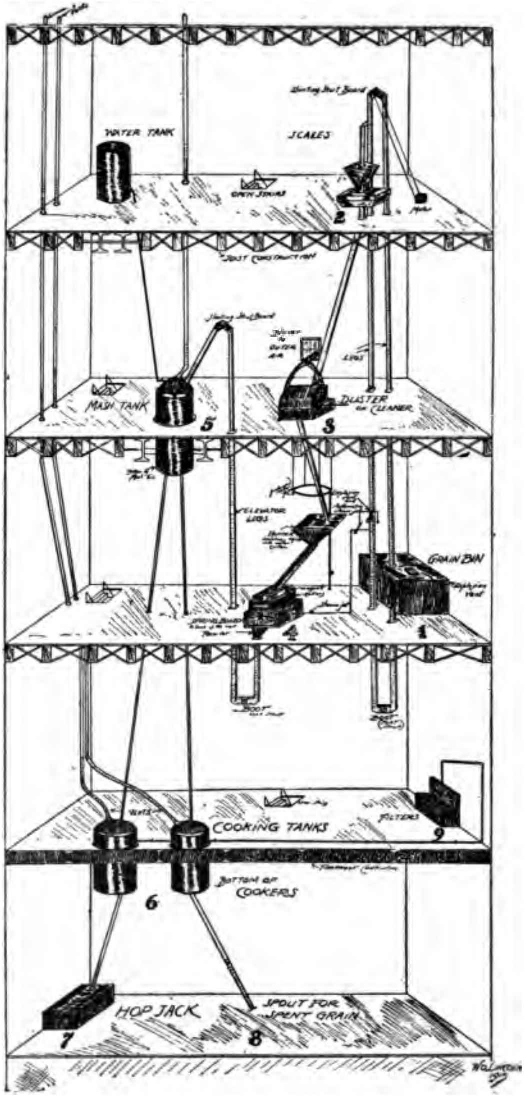
building—usually one equal to four stories high—with a brick and iron constructed furnace, on ground flooring, which has an open top, capped with a metal hood to prevent any falling grain from dropping on the furnace. Above the furnace are floors of heavy, fine wire mesh, below each of which are steel shutters operated by hand-wheels on the side wall, attached to a bar which revolves the shutters. The grain is shoveled in on the mesh floors from the growing floors, and when same is properly leveled, the shutters are opened and the heat from the furnace passes up through the grain, and it is transformed into a crisp condition, which checks all further germination, being stirred occasionally by a row of wooden paddles running on side rails. It is then sent to bins for storage until needed for the brew. The roof of the kiln house should always be of fireproof material, including the suction-fan apparatus always located here to draw off and prevent confinement of heat. At this point many fires have occurred. As the germinating house and kiln house are invariably communicating, fire doors should be installed at all openings, but usually sheet-iron doors are employed.

Leaving the Malting process, we now pass to the brew house. This is usually one equal to six stories, having large floor openings, consisting of stair and elevator shafts and spaces around kettles and tubs, which extend from one to two floors.

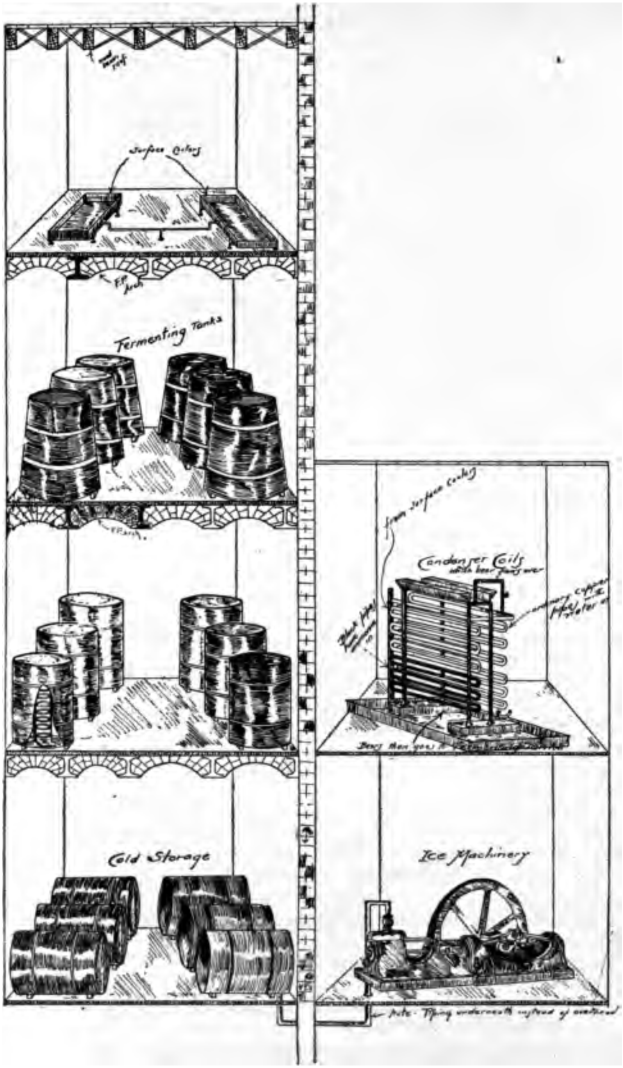
Brewers are fast replacing old-time wood-joist and board-floor construction in brew houses with fireproof material. The large, open-area feature will probably never be fully eliminated, because of convenience afforded it.

The grain is received here from the maltster and lofted to the storage bins, from which it passes to the screeners and weighing machine, and thence into the malt mill, which is a crushing machine consisting of rapid-motion steel rollers, which should have a series of steel magnets so arranged as to attract and hold all metallic matter which might, if unhindered, pass to the rollers, create sparks and cause an explosion. Also there should be provided an automatic live steam jet, the operating of which would serve to smother all flame in the mill box. As the grain leaves the rollers, it passes to a hopper, through a crevice between two spring boards, which tend to pack the grist against the rollers and prevent the spread of a spark fire.

From the mill the grist passes to the mash tubs, where it is mixed mechanically with hot water, and incidently with any of the adulterants the brewer may elect to use. After remaining in the mash tub a few hours, the liquor resulting, known as the wort, is drained off, and then passed to the brew kettles, which are large, steam-heated, jacketed, copper tanks, vented to the outside, and boiled with hops. From the brew kettles it is either filtered, and thence piped to the cooler house (the spent hops being drawn from the kettle through a spout), or the


WATER TANK
SCALES
Shifting Spout Board
OPEN STAIRS
Motor
2
JOIST CONSTRUCTION
Shifting Spout Board
Blower to Outer Air
Legs
MASH TANK
5
DUSTER or CLEANER
3
ELEVATOR LEGS
GRAIN BIN
4
1
BOOT
BOOT
Water
COOKING TANKS
FILTERS
9
BOTTOM OF COOKERS
6
HOP JACK
7
SPOUT FOR SPENT GRAIN
8

Brew House.



COLD STORAGE HOUSE.

contents of kettle are dumped into a hop jack, where liquor is pumped to the cooler house, where the fermentation takes place in large wooden vats.

Except in the old, out-of-date breweries, the cooler or refrigerating house is always of brick, arched-ceiling and cement-floor construction to the top floor, which has an ordinary joist roof. All the floors below the top are used for fermentation purposes, and the top floor for storage of hops in bales. The reason for using fireproof construction in these cooler houses is that they are always wet and damp, and ordinary wooden construction would soon rot and become defective.

After fermentation process is completed, the beer is drawn off into kegs or barrels and stored into cold vaults. The cold storage portion of even the smallest brewery is so extensive that the ordinary ice bunkers are inadequate, so the brewer naturally has an ice machine or refrigerating plant connected with his brewery. This apparatus should be so located that a fire in his brewery would not compel the shutting down of the refrigerating machine. The service pipes from the machine to cold-storage vaults or floors should be under and not over the brew house. Ice is also made both for owner's use and for the trade.

HAZARDS.

The main hazards to be considered are the following:

In the growing house, none of serious importance.

In the kiln house, the hood over the furnace should be arranged to chute any falling grain from the furnace, and the roof ventilator well protected and kept free from oil and dust.

In the brew house, malt bins and chutes and lofter boxes should have automatic explosion traps. The strut boards in lofters, over which pass the buckets, should be slanting.

The malt mill, magnets and live steam-jet protection and spring boards.

Cooper shops, keg branding and painting shops should be separated from the brew house.

The old process of heating pitch by furnace fires should be replaced by the new type of steam heating of pitch.

Brewers are accustomed to fit up saloons for customers who pledge to handle their beer, and if such saloons fail to be paying propositions, the brewer is compelled to take back his fixtures, and must necessarily repair and refinish them for use elsewhere.

This custom naturally adds the very serious hazards of fixture storage, of a cabinet shop for the woodworking, of a plumber and tinning shop, and of a painting and varnishing shop for the refinishing work.

CLEANING AND DYEING RISKS.

Interesting and Instructive Pointers Sent to Members of Iowa State Cleaners' and Dyers' Association on Their Fire Hazards.

From circular by Iowa Inspection Bureau.

To Members of Iowa State Cleaners and Dyers Association:

It is with a great deal of satisfaction that we note, from press reports, your determination to use your concerted efforts to minimize the fire hazard incident to the conduct of your business, thereby reducing the fire waste of the State of Iowa.

It is therefore, with great pleasure, that we tender you our assistance, the result of our experience, and coöperation in securing compliance with established standards through the adoption of which the fire hazard is reduced to an absolute minimum.

We are attaching a blue print of a plan adopted by one of your members and recommended by this office. Insurance estimates advised on this property are as follows:

Pressing section building.....	$ .67	per $100 per annum
Pressing section contents.....	1.01	per $100 per annum
Washer section building......	1.07	per $100 per annum
Washer section contents......	1.40	per $100 per annum
Boiler House building........	74	per $100 per annum
Boiler House contents........	.74	per $100 per annum

We know of no risk of this character in this State where our estimates are any less than above quoted, indicating the highest control of the fire hazard.

The following standards are suggested for your consideration:

Confine washer section to a separate division having four solid brick or reinforced concrete walls, reinforced concrete roof, cement floor, wired glass skylights in metal frames so hinged as to open upward. If communication with other sections is necessary, provide all door openings with standard fire doors, one door on each side of the wall.

Confine drying section to separate division following same construction as indicated for washer section. Steam pipes, if used in drying section, to be attached to side or hung from ceiling rather than placed at bottom of enclosure.

Confine boilers and any heating apparatus to separate section following same construction as indicated for washer and drying sections. Avoid any communication between boiler room and washer or dry room.

CONSTRUCTION

In building avoid use of ordinary frame, frame iron clad, skeleton iron clad, hollow tile, cement block, or brick veneered construction. Use stone, good hard burned solid brick, or reinforced concrete.

Limit height of washer, dry rooms, and boiler room to one story and avoid basement or spaces under floor.

EQUIPMENT

Use only approved systems of storage and distribution, introducing cleaning liquids into the building only through the same. Tanks must be underground outside of building walls with outside vent and fill pipes.

Use only such washers as can not be opened until liquid has been drawn off.

Provide vapor proof cover if liquid flows from washer into hopper.

Provide vapor proof cover for all extractors.

Provide open steam jet, operative from point outside of room, at ceiling and floor level of washer room.

Provide open steam jet, operative from point outside of room, at ceiling and floor level of dry room.

Avoid subjection of liquid to vaporization.

VENTILATION.

Provide ventilating fan at floor level of washer room.

Provide ventilating fan at floor level of dry room.

LIGHTING.

Use only incandescent electric lights (preferably in vapor proof globes) with keyless porcelain sockets, with switch located outside of dry or washer rooms.

Portable lights if used should be provided with wire guards.

FIRE EXTINGUISHING APPARATUS.

Any labeled chemical extinguisher is acceptable, but the one quart labeled Pyrene extinguisher has, after exhaustive tests, been found very efficient on incipient fires in materials where water or solutions containing large percentages of water are not effective and where gases generated from it can be confined. It is particularly effective in incipient fires in dry cleaning establishments.

Buckets of dry sand are likewise recommended.

Two Pyrene extinguishers are recommended to each 2,000 sq. ft.

of floor area in washer and dry rooms, but not less than one extinguisher in each room.

GENERAL.

Address this office for specifications for standard fire doors, fire shutters, wired glass window frames and chemical extinguishers.

Avoid unprotected openings in side and rear walls, protecting same with fire shutters and wired glass windows.

Note Section 4999 A13, Page 1086, Supplement to Code of Iowa of 1907.

"Use of dangerous fluids forbidden: That it shall be unlawful for any person to establish or operate any dye works, panitorium, or cleaning works, in which gasoline, benzine, naptha, or other explosive or dangerous fluids are used for the purpose of cleaning or renovating wearing apparel or other fabrics, in any building any part of which is used as a residence or lodging-house."

"Penalty: Any person convicted of violating the provisions of the foregoing section shall be fined in a sum not exceeding fifty (50) nor less than ten (10) dollars."

In conclusion, permit us to state that we are decidedly with you in your efforts to reduce our fire waste, and only ask that you confer with this office, giving us an opportunity to assist you in protecting your property and incidentally in so arranging your premises that we will be warranted in naming only minimum insurance estimates.

If you contemplate the erection of a new building, we will be indebted to you if you will permit us to examine your plans and specifications and to submit to you our criticism of same with suggestions whereby criticised features can be eliminated.

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OXYGEN TANKS IN FIRES.

Interesting Account of Behavior of Various Types Under Stress—Construction Described.

By Russell Raymond Voorhees, Newark, N. J.

[Fire insurance inspectors who have occasion to examine risks in which the use of oxygen gas is a factor will be very much interested in a remarkable comparison of the effect of a serious fire on two common types of gas containers and one new type afforded by the fire in the Linden, N. J., plant of the Linde Air Products Company on the night of August 15, 1914. Mr. Voorhees made a personal inspection of the ruin and has written instructively concerning the fire and its lessons.—*Ed.*]

On Saturday night, August 15, at about 9.50 o'clock, the Linden, N. J., plant of the Linde Air Products Company was visited by a fire and explosions which caused the death of two men and a boy and injuries to three others. The Linde Air Products Company is a large manufacturer of oxygen gas and have also plants at Buffalo, East Chicago, Ind.; Trafford, Pa.; Oakland, Cal.; Detroit, Mich.; Norristown, Pa.; Cleveland, Ohio; Worcester, Mass.; and North Kansas City, Mo.

The building at Linden was one of their older plants and was built of concrete and brick and was "fireproof" with the exception of the roof, which was of slow burning construction, and the office partition and furniture which were of wood.

The feature that is most prominent is the severe test that the oxygen tanks were put to and the result. In the plant at the time of the fire and explosions were three types of tanks: the old style low pressure tank, the old German type of high pressure tank and the new safety type of high pressure tank. All three types were subjected to the same severe test, but with different results.

Several of the low pressure tanks with oxygen at a pressure of 300 pounds to the square inch exploded, while on others the brazing melted and the force of the oxygen within was enough to send the bottom of the tank through the air with great force. About the only thing that can be said for these low pressure tanks is that those which exploded remained in one piece, showing that the formula of the metal was excellent.

The four old German type high pressure cylinders behaved in about the same manner. Fifty of these tanks were exposed and they were filled with oxygen at a pressure of 1800 pounds and were equipped with a metal disk without backing. As the tensile strength of metal varies it is almost impossible to calculate accurately just what pressure will be required to break this disk and allow the imprisoned gas to escape. Although these discs were supposed to act at a certain pressure it is quite evident that four did not, but rather continued to act as a check after the required pressure had been reached and still continued to act as a check until the tank exploded. Another point worthy of mention is the fact that these tanks were made of steel after the German formulæ which differs in some respects from the American formulæ. It is claimed that the American steel has a

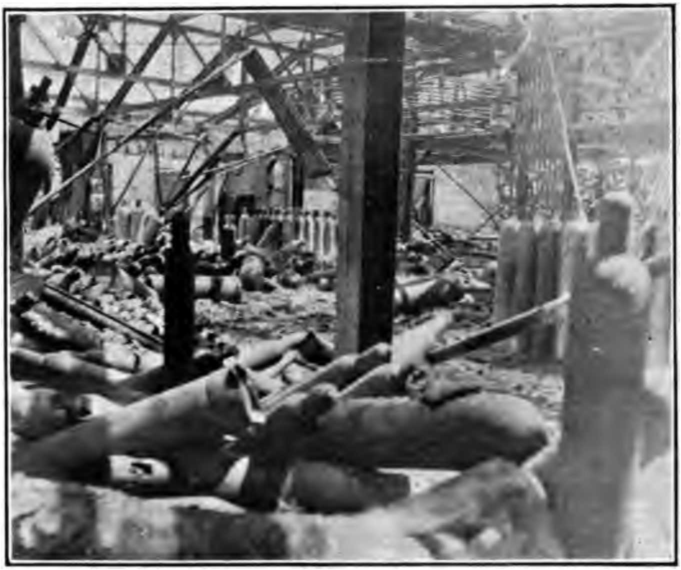


FIG. I. GENERAL VIEW OF BURNED PLANT.

A careful investigation of the circumstances has so far failed to determine the cause of the fire. The plant was built with a view to eliminating all possible causes for fire, and every known hazard has been followed up and eliminated as a possible cause. As yet the cause of the fire is a mystery to the owners.

better formulæ than the German steel. As in the case of the low pressure tanks, however, the German tanks did not fly in pieces like a bomb, but upon exploding remained in one piece.

Chief interest, however, centered around the new safety type of high pressure cylinders of which three hundred were present. These were filled with oxygen at a pressure of 1800 pounds. They were fitted with a thin disk of copper alloy backed with a fusible plug made of another alloy and which would melt at a temperature of 206° F. Although the requirement for such plugs specifies 212° F., the Linde people wanted to be on the safe side, so they ordered their plugs to be made with a melting point of 206° F. When the temperature rose to 206° F. the plug melted, releasing the disc and the oxygen escaped without harmful effect. The fact that is worthy of mention about these safety tanks is that not one exploded but that all remained intact. These tanks were made of American steel and were the best that it is possible to construct.

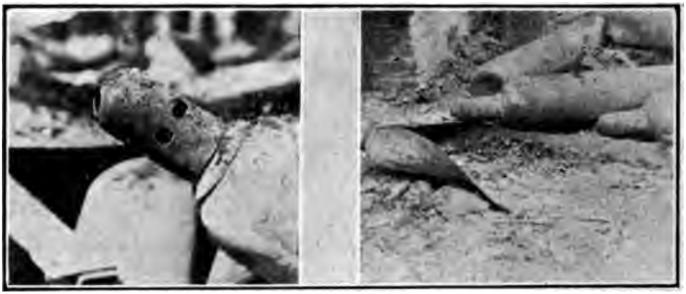


FIG. 2.

THE NEW TYPE CYLINDER, SHOWING SAFETY ESCAPE APERTURES ENLARGED BY THE ACTION OF THE OXYGEN IN RUSHING OUT.

OLD TYPE GERMAN CYLINDER, WHICH EXPLODED, BUT REMAINED IN ONE PIECE, SHOWING VALVE FAILURE, BUT ELASTICITY OF METAL.

The low pressure tanks, some of which exploded, were the type formerly used by the customers of the Linde people, but which were being discarded as fast as possible.

The new style safety cylinders that behaved in such a faultless manner were of the type that is being used by the Linde Air Products Company and the experience is pleasing, as it demonstrates that cylinders made in accordance with the new rules of the

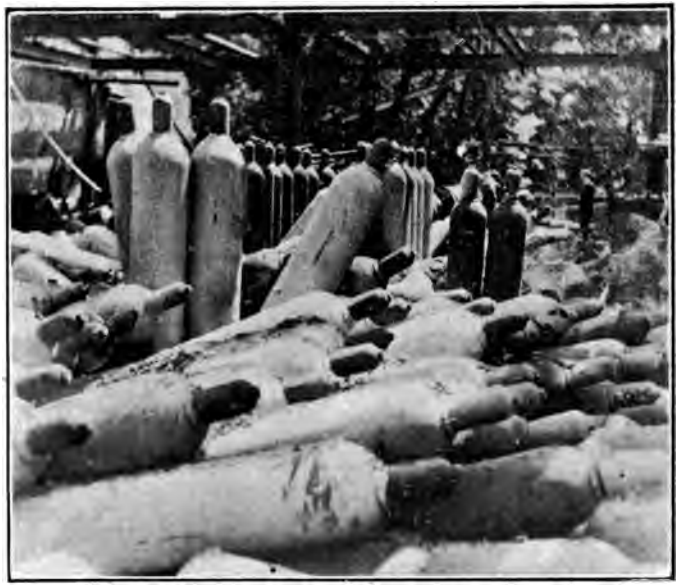


FIG. 3.
VIEW OF SOME OF THE 300 NEW SAFETY TYPE CYLINDERS, NONE OF WHICH EXPLODED, THOUGH SUBJECTED TO WHITE HEAT. EACH WAS FILLED WITH OXYGEN AT 1,800 POUNDS PRESSURE.

Interstate Commerce Commission may be expected to go through fire without hazard to the users, and their presence in a risk is a guarantee that in event of fire the oxygen gas will be released without explosion. Inspectors should see that the cylinders are stored where, in the event of fire sufficient to melt the fusible plugs, the gas may be set free into as large space as possible.

GARAGE FIRES.

Prevalent Causes of Fires in Garages Discussed, with Practical Suggestions for Betterment of Conditions.

By Wm. M. Klinger

Whether most garage fires are caused through smoking or the careless handling of gasoline is problematical. It is claimed that many fires are due to difficulty in starting a motor—probably the electric spark won't ignite the mixture, the carburetor is flooded, the gasoline overflows into the drip pan or on the floor, and when the motor does start the explosion through the muffler may ignite the vapor rising from the liquid gasoline on the floor. One fire was started by a spark from an iron nail in the heel of a shoe as it scraped over the cement floor.

Conflagrations have been caused though filling the gasoline tank when the lamps are lighted. Many automobiles have dashboard tanks with the opening too close to the sidelights, while the pressure-fed cars have the tanks conveniently located at the rear, close to the tail lamp. Cars constructed in a more modern way have electric side and tail lamps, thus eliminating this hazard.

Smoking should be prohibited by ordinance; mechanics who have formed the habit of smoking while working on a car lose all sense of precaution. There is always a chance of a tool striking the gasoline pipe, causing a leak, which may be unobserved, but in sufficient quantity to cause a gaseous vapor, which when accidentally lighted by a spark from a cigarette, cigar or pipe, may result seriously. The use of gasoline for cleaning purposes is one of the most serious hazards that confront the underwriter.

Garage fires have been of such frequent occurrence that it is necessary for underwriters to insist that the rules for prevention of fire be carried out. Dynamos or gas engines should not be permitted where gasoline is handled or stored; heating stoves and all exposed lights should be eliminated; acetylene lamps should be cleaned outside of garage; removal or renewing of carbide should not be allowed inside the building. Oil and gasoline should be emptied and tank cleared of gas through introduction of air pressure before automobile is placed in repair shop. Electric-light bulbs should be encased in wire guards; testing of motors should be done outside the building. Lubricating and other volatile oils should be contained in heavy barrels or tanks as far away from building as possible. Gasoline should be stored in tanks at least four feet under ground and outside of garage; filling should be done outside of garage. Floors should be kept free from drippings, and buckets of sand or approved fire extinguishers should be kept handy. Danger lurks in garages having cement floors and a wash drain; oil and gasoline waste flow down the drain, but float on top of the water in the trap; the gasoline throwing off its explosive vapor, a lighted match or any other spark or exposed flame, or live fire of stub of cigar or cigarette, causes an explosion, with the inevitable result.

The Chicago Board of Underwriters, realizing the hazard in connection with garages, recommends the following rules:

Gasoline supply tank to be buried four feet below the surface of the ground, as far from building as possible up to thirty feet;

Gasoline pump, if inside building, to be of approved design;

Automobile tanks, if filled inside building, to be connected by substantial tubing (not exceeding seven feet in length), to approved pump or to approved portable tank. Tubing to be attached permanently to pump or tank, and is to be provided with a quick-closing valve;

Approved portable tanks, if filled inside building, to be connected by substantial tubing (not exceeding seven feet in length) to approved pump;

Gasoline, other than above, used inside of building, to be transported only in approved one-gallon safety cans;

The use of gasoline, benzine, naphtha, turpentine or other liquids of a similar nature for cleaning floors, or in open vessels for washing hands or machine parts, etc., should be prohibited;

All rooms in which gasoline vapors are present to be properly ventilated;

Repair shops or other rooms where oil is used or stored to be provided with pails of sand or approved chemical extinguishers;

Chemical extinguishers to be recharged every six months and to bear a tag stating date of last charging;

Heating (in rooms where gasoline vapors are likely to be present) to be by steam, hot water or furnace; boiler, heater, or furnace to be isolated from gasoline vapors;

Incandescent electric lights to be used in rooms where gasoline is used or contained. Extension lights to have vapor-tight globes and approved portable cord;

Open lights of all kinds (gas-jets, lamps, torches, candles, etc.) to be prohibited except in office or ware-room;

Lighting of matches in any room where gasoline is present to be strictly prohibited except where necessary in repair shop;

Smoking to be prohibited in every room in which gasoline is used, stored or handled; "No Smoking" signs to be posted in conspicuous places;

Calcium carbide, if carried in stock, to be in approved metal cans constructed in accordance with rules furnished by this Board;

Tanks containing acetylene gas, if carried in stock, to be limited in number to five, not including those on cars;

Repair shops to be provided with approved metal waste cans. Cans to be emptied at least once a day, and especially at closing time;

Soldering irons, if used in building, wired for electricity, to be approved electric.

Asbestos.

Asbestos is one of the most peculiar and marvelous productions in organic nature. Called by mineralogists asbestus, the name in its Greek form signifies unquenchable, inextinguishable, inconsumable.

It has been called a "mineralogical vegetable." In mineralogy three minerals are classified under the term "asbestos," namely, antophyllite, amphibole and serpentine.

1. Antophyllite, which is not used commercially.
2. Amphibole or hornblende asbestos. This includes various varieties, among which are actinolite and Italian asbestos.
3. Serpentine asbestos, which has three fibrous forms, namely, picrolite, soapstone or talc and chrysotile. The chrysotile asbestos is a variety found in the Canadian deposits and is the only variety which is of much economic value.

In appearance and mineralogical character these varieties are somewhat different, while in chemical composition they are very similar. The amphibole varieties being silicate of lime and magnesia and alumina, while serpentine is a hydrated silicate of magnesia. The following is about the average chemical composition of the Canadian chrysotile asbestos, viz.: Silica, 40 per cent.; magnesia, 42 per cent.; ferrous oxide, 3 per cent.; alumina, 1 per cent.; water, 14 per cent.; total, 100 per cent.

While asbestos in one or other of its varieties has been found in many States of the United States, in Italy, South and Central America, China, Japan, Australia, South Africa and other parts of the world, none of these deposits so far have proved to be of much economic value, or are so located that they cannot be worked profitably.

About 80 per cent. of the world's production of commercial asbestos is being supplied from the Canadian deposits. Russia is the next largest producer of commercial asbestos.

CORK-WOOD AND ITS FIRE HAZARDS.

Attitude of Underwriters Toward Cork and Its Results—Ordinary Processes of Manufacture—Recommendations—Protection Systems.

By Gilbert E. Stecher, Surveyor, Home Insurance Co., N. Y.

The general disposition toward cork-working plants has been one of antipathy, because of the frequent burnings and the losses attending them, and the meager explanation of the possible causes of the fires. This condition, extending over a period of years, has naturally and most justly caused underwriters to question the desirability of insuring cork-working plants under the present mode of doing business, and in the interests of their loss record, they have been forced to stop writing them or secure exorbitant rates. This position on the part of the underwriter has to a limited extent had a good effect upon the cork trade, as it has aroused a general disposition for better care and management of the individual plant, and has also called forth a demand for better fire protection, which, fortunately, has assumed the shape of automatic sprinkler protection.

THE FIRE HAZARDS

attending the manipulation of cork-wood are not numerous, as the processes are simple and but little machinery necessary; but the trade demands call into operation a few additional features, which, taken all together, make a cork factory not simply a cork-wood factory in the true sense of the word.

To start from the beginning, we have learned by experience that cork-wood will burn, and rapidly, too. This fact must never be lost sight of, as the material we are dealing with is only under discussion because of it. To do business in cork-wood articles it seems to be the general rule that a large stock must be carried, and this large stock is the first danger point. Great quantities of cork-wood, even in bales, presents a large surface of highly combustible material, and fire once started by a spark, careless match, cigarette or what not, spreads over it with miraculous rapidity. If it is stored in a building used for manufacturing, the result depends on how fire resistive the structure is and how promptly the firemen apply the water.

IN THE PROCESS OF STEAMING

the cork-wood before cutting, the old familiar "steam-pipe-in-contact-with-woodwork hazard presents itself, and although exhaust steam may be used for this purpose, the danger, perhaps lessened, is still apparent and must be met.

The cutting, punching, tapering and shaping involve no particular hazard, other than the possibility of a hot bearing in machinery used for the work, yet this is an important feature and must be carefully looked after. After the corks or stoppers have been given the desired commercial shape, there remains two operations which may be termed the finishing touches: the ends of the corks in most instances are a trifle uneven or soiled, either by handling, stone cells or Jasperado, so must be made clean and smooth, this being done by holding them against a vertical revolving sandpaper wheel, the resultant dust also becoming a factor in the fire hazard; and after all the mechanical manipulation the corks go through the bleach to make them acceptable to the æsthetic taste of the trade.

This bleach ordinarily is non-hazardous and passes from our notice, but some genius has found a few bleaches of cork to worry the underwriter in the form of formol, sulphur, lime and ethyl alcohol, their presence naturally adding to the possibility of fire and calling for regulation.

If the industry stopped at this point all that is to be said would have been passed over, but this, like other industries, is conducted for profit and therefore utilization of scrap plays an important part in this narrative. The demand for the superfine or champagne cork has created an apparent shortage in the thick bark necessary for their manufacture; so dealers to-day utilize a thin grade of superfine cork-wood for making "champagnes" by cementing or gluing two pieces together, and the binder used is rubber dissolved in carbon disulphide in most cases. This then presents a serious hazard and must receive the proper safeguarding.

THE INTRODUCTION OF THE CROWN SEAL STOPPER

has also brought with it undesirable features in the form of paraffining the discs to insure water-tightness and retard discoloration, and the making of waterproof paper by dipping same in rosin. The crown seal stopper making has crept into cork manufacture, and no doubt is there to stay, so that now, in considering the hazards of a cork-wood factory this new feature must also be seriously considered.

The crown seal is made up of a tin cap, corrugated on the lapped edge, for gripping the top of the bottle, a cork-wood disc, and a waterproofed paper between the cork-wood and tin cap—a very ingenious invention.

The paraffining of the discs is a simple operation and is performed by heating the wax and dipping the disc into it, gas or steam being the usual heating medium, the making of waterproofed paper being a similar operation, only rosin, paraffine and copal gum is used—a somewhat more dangerous material.

Now, from the various operations there accumulates a vast quantity of chips, odd pieces, etc., which are carried usually to the basement and made up into bales, this baling either being done by hand or electric power. These chips form a large item of a cork-stopper factory and are used in many ways, but to describe the conversion of this scrap we will confine ourselves to the operations presenting a fire hazard on a large scale, i.e., grinding, cork insulation manufacturing and the making of Spanish black.

IN THE GRINDING OF CORK

there is a grave hazard, as the dust is easily ignited and its explosive quality is rather high. Large fires have not been traced to grinding as the cause, but that does not prove the danger does not exist. All combustible dust is explosive under certain conditions, and therefore the nature of cork dust makes it reasonably certain that this presents a hazard of no mean degree and should be carefully guarded. The general practice in the trade is to use an ordinary iron mill for general grinding, and this being adjusted also for fine grinding, the character of the mill apparently not affecting the fire hazard, for any mill, if not properly taken care of, would create an objectionable condition.

The oven process of making cork insulation presents a low hazard and calls only for proper insulation of all exposed woodwork. The other process of slab making, involving the use of tar and pitch, steam pitch kettles and saws, is a different type of hazard.

This, as it will be seen, creates not only the hazard due to the presence of the material, but of the pitch kettle and the dust of the saws, and becomes rather serious in the absence of any protective system.

THE MANUFACTURE OF SPANISH BLACK

resembles that of lamp black, but instead of being the product of a burning oil, is the result of a carbonization of cork-wood in a closed vessel and a subsequent grinding in an iron mill, the danger attending being rather more in the material itself than the mode of manufacture, as the latter calls only for proper heating mediums and insulation, while the product, so susceptible to spontaneous combustion, must constantly be watched. Too much moisture or oil in the cork-wood, while being carbonized, makes it necessary to exclude all air or else fire ensues. And the finished product must be kept free from moisture also. The grinding presents a dust hazard, which is a serious one and fraught with danger if not allayed.

These foregoing hazards and dangers pointed out in the particular instances cover the general hazards found wherever corkwood is worked. It may be one or a combination, but the character of the hazard remains the same, so that in place of enumerating where these hazards are met with, the individual can deduce that for himself.

RECOMMENDATIONS

Baled cork in quantities should be stored as follows: If in a city, where much space is not to be secured, care should be taken to store same in some cut-off section of the building and in as small quantities as possible; make sure there are no floor openings in the immediate vicinity of this storage, and make the floors over and under same perfectly watertight; but arrange the ventilation so that in case of fire the gases created will not force out the enclosing walls. If outside of the city, this baled cork should be stored in a detached house, away from any possibility of the ground being covered with chips, etc. These foregoing recommendations apply also to baled cork chips and the large quantity of corks that accumulate in the utilization of small bark and odd pieces.

Steam pipes should be properly insulated from all woodwork, and as air is the greatest cooling medium, it is advised that where the pipes pass through or near wood an air space of 2 inches be allowed, or 1 inch with the wood properly guarded by a metal thimble.

THE SUBJECT OF BEARINGS OR JOURNALS

is just as pertinent to a cork risk as to any other, and their care most necessary. The ordinary journal, if kept properly oiled, is acceptable, but without a drip pan it is a danger, as the oil mixing with the cork siftings is liable to create heat, therefore don't forget the drip cups on all journals.

The dust from sandpapering machines should be carried off by a good suction blower and be discharged into a tank of sufficient size to contain the amount made in the allotted time between the set days for emptying same, this tank to contain water in sufficient quantity to moisten the dust blown into it.

As previously stated, there are a few chemicals used in bleaching that attract our attention. Although used seldom, they may be present, and therefore must be reckoned with. Formal or methylal is one, made by distilling methyl alcohol, sulphuric acid and manganese dioxide together. It is colorless with a chloroform odor and volatile, boiling at 42° C. Ethyl alcohol or spirit wine, made from grains, starch or sugar, is another. This is also colorless, with a piercing, agreeable odor, volatile, boiling at 78.5° C.; and lime is the third bleach, so well known as to need no special mention. The other bleaches will readily be found to be harmless if ordinary care is taken, but the above-mentioned ones must receive extraordinary care. To lay down any set of rules as to quantities would not be good judgment, but it might be stated that a day's supply is all that should be allowed in a building at any one time, and the main supply either be kept in the yard in an unexposed position, or, if in the building, in a fireproof vault, answering to the specifications drawn up by the underwriters.

Disulphide of carbon, mentioned as a solvent for rubber, in making the two-pieced "champagnes," must be handled with the same precautions as the dangerous bleaches named, with this difference: ventilation should be from the bottom and open cans avoided as much as possible. Keep this material well covered at all times. It is highly inflammable, volatile and boils at 46° C., and has a peculiar odor.

The sulphur used for bleaching is in itself quite harmless, as it is usually of the stick form, which does not readily ignite; but in the use of it for cork bleaching the hazard arises, for here it is generally burned in closed rooms. Sulphur in burning melts and spreads, and unless confined in a metal pot on a brick or concrete floor, bleaching by this process should be debarred.

THE PARAFFINING OF THE DISCS

presents no further hazard than the medium used in heating the paraffine. This is generally gas, or sometimes steam, and of course the latter is preferred, as with the open flame there is always that change of the flame and paraffine coming together and causing fire in the plant. If the melting is done in a fireproof room the damage is localized, and that is what I suggest—that paraffine melting for coating cork discs be done in a fireproof room, cut off from other portions of the risk; that steam be used as the heating medium; but if gas is used, the construction of the kettle to be such as to prevent the possible overflowing paraffine to come in contact with the flame.

Rosin melting in the making of waterproof paper should receive the same attention as the paraffine melting, but with more attention to the heating medium. In the process of rosin melting I would suggest that only steam be used, and that a man be stationed at the kettle at all times during the melting, constantly stirring the mass, as the great danger in rosin melting is the frothing. A mechanical paddle of course would be most acceptable, but in the majority of cases the rosin kettles are small and a hand paddle more convenient.

around the baling press became apparent to me not long ago when, while watching the process of dumping the cork scrap into the press, I noticed the air became full of little floating particles, which enveloped an open gas flame just above the press, and coming in contact with it, caused a corruscation and sparkling within the flame. This clearly showing that if there had been enough cork dust there, with the right proportion of air, the results might have been sad to relate. Therefore I advise no open lights in the vicinity of the baling press and the location of the press in some cut-off section of the plant.

The dangers of cork grinding have been enumerated, and the precautions necessary are to carefully adjust all mills; avoid foreign particles of metal from passing through the mills by placing magnets in the top of same; keep all bearings well oiled, all shafts in alignment, and install a good exhaust fan system to carry off all the dust to the bins, using only metal ducts, and these to have dampers within them, with fusible link attachments.

IN THE OVEN PROCESS

of making cork chip insulation slabs, the feature to be guarded against is naturally the oven. This should be constructed in a safe manner and all exposed woodwork properly covered with metal; but preferably housed in a brick building, where wood does not enter into the construction. The saws sometimes used for trimming up the edges should also have the blower attachment and the dust be handled as noted before.

In making pressed pitch and cork-chip slab there is the storage of pitch, a harmless material under ordinary circumstances, but in a fire it makes a nasty proposition to extinguish. I suggest that this pitch be stored in a cut-off section of the plant and only the necessary quantity for a few batches brought out at a time, so that it is not unnecessarily laying around. If the plant is in the country, keep the pitch out of doors. Steam pipes must be kept clear as stated and the saws used for cutting up the blocks into slabs should be located in a cut-off section of the plant and a good blower system be installed to carry off this black dust.

Spanish black making, besides involving the hazard of spontaneous combustion in the material if too oily or moist, also incurs a dust hazard from the grinding process—the former to be avoided by proper arrangement of the carbonizing kettle, steam pipes, exposed woodwork, etc., and excluding the air from the kettle while carbonizing the cork-wood; the latter by properly aligning the belt shafting, keeping the bearings well oiled, avoiding foreign particles from passing through the mill and installing a good suction blower to free the air of floating particles. It is a well-known fact that cork dust will remain suspended in air an infinitely long time. Never store this material in other than fireproof rooms, and in as small quantities as possible. Its manufacture should be confined to a fireproof section of the plant, if done in the city, and be separated from the plant where the space will permit.

IN ENUMERATING THE HAZARDS

attending the various manipulations of cork-wood, it hardly seems necessary to state that the power plant should be cut off from the main buildings by the usual standard of brick walls and approved fire doors, but this feature is very essential, as the nature of the work will prove. To all these recommendations I desire to add that there must be unfailing care of matches, oily waste and rubbish, and the plant kept clean at all times, for against our theory and deduction of possible hazards there stands a loss record caused by the match carelessly thrown, oily waste and rubbish spontaneously igniting, and the other numerous small causes that escape the general notice, making the inherent hazard the safest to contemplate.

I desire in closing to say a word about

FIRE PROTECTIVE SYSTEMS

in cork-working establishments. From the observation of fires in this class there is no doubt that the rapidity with which the flames spread makes the use of ordinary extinguishing devices such as pails, standpipe and hose and the portable acid extinguisher out of the question after it has gotten any kind of a start, so that automatic sprinklers seem to me to be the only efficient protective device; but in the event of their installation I strongly advocate a first supply under heavy pressure and a large secondary supply, as the possibility of numerous heads being opened at one time is so present that if there is not sufficient water the result will not be satisfactory.

Sprinklers have shown an excellent record in coping with dangerous material, but mostly confined to a section of the plant or building; that is, being only part of the process. In a cork-wood factory we find cork in large quantities from cellar to roof, the floors more or less filled with dust and scrap, so that the condition to be met is a flash hazard, which the large cork fires have proven to be dangerous in the extreme.

RECENT FIRES

have occurred in cork risks originating in the rosin boiling room and also in cork scrap, but both in plants where this particular space was small and not in buildings usual to the class, which sprinklers controlled, speaking well for them and favoring their installation.

In speaking of the hazard of cork grinding, the statement that large fires could not be traced to this cause was made, and in support of that statement I affix the list of important fires from 1877 to 1911, a period of thirty-four years, and causes as reported:

1877—Norwich, Conn. Cause unknown.
1878—Pittsburgh, Pa. Cause unknown.
1891—619 Ninth Ave., New York City. Cause unknown.
1897—Brooklyn, N. Y. Cause unknown.
1898—Bridgeport, Conn. Electric wires.
1898—Bridgeport, Conn. Electric wires.
1906—Brooklyn, N. Y. Overheated boilers.
1907—Mexico, Mexico. Fire from balloon.
1907—Brooklyn, N. Y. Cause unknown.
1907—Brooklyn, N. Y. Cause unknown.
1908—Emporia, Kansas. Cause unknown.
1908—Newark, N. J. Cause unknown.
1908—Brooklyn, N. Y. Cause unknown.
1908—Brooklyn, N. Y. Electric wires.
1909—Brooklyn, N. Y. Exposure.
1910—Brooklyn, N. Y. Cause unknown.
1910—Jersey City, N. J. Cause unknown.
1910—Brooklyn, N. Y. (2 in 2 months). Cause unknown
1911—Brooklyn, N. Y. Cause unknown.
1911—Brooklyn, N. Y. Rosin kettle.

COMBINED HEATING AND SPRINKLER SYSTEMS.

Interesting Experiments Looking Toward Twofold Utility of Sprinkler Piping Systems. Remarks as to Practicability.

By C. B. Mackinney, Insurance Engineer, with Starkweather & Shepley, Providence, R. I.

Some authorities state that the idea of circulating hot water in an automatic sprinkler system either for heating the building so equipped or as a substitute for the dry system, or both, is an old one. The practical development of the scheme and the actual installation of equipments is however of quite recent date.

General Appearance of Installation.

THE FIRST EQUIPMENT OF THIS SORT known to the writer was installed in New Bedford, Mass., about three years ago. Since then several quite large buildings have been equipped. As it is possible that the idea may spread and these equipments become more general, a brief description of this arrangement of piping and apparatus may be of interest.

The principal reason for installing the system lies in the economy of using the sprinkler piping for heating purposes and automatic sprinkler service at the same time, thereby saving the cost of erecting the usual two separate sets of piping. Usually the sprinkler piping alone will only heat a building moderately, and in rooms where people are at work or for any other reason more heat is required, auxiliary heating coils or radiators are installed.

THE DETAIL OF THE SPRINKLER PIPING is as we are accustomed to see it, except that the end of the lines distant from the mains are all connected into one or more return mains.

The pipe sizes and the spacing of heads is according to the usual standards and the piping is hung up and pitched to drain just as in an ordinary system. The water supplies are arranged for in accordance with the usual practice, and the usual gate and check valves are installed. So far there is nothing strange about the system, but from here on it is very different.

Some type of heater or boiler for heating the water is installed. What is known as a feed water heater is sometimes used for the purpose.

The piping connecting up the ends of the sprinkler lines is all brought to a center. A pump is connected between this center and the heater. The other end of the heater is connected into the bottom of the main sprinkler riser, or risers, if there is more than one, inside the check valves. When the pump is running, water is forced through the heater up the risers of the sprinkler system along the lines on the different floors and back to the pump through the piping connecting up the ends of the lines. The pump sets up a pressure in excess of that of the water supplies. This tends to keep the check valves shut, and no hot water goes out into the underground piping. It takes very little power to do this, as the whole system, including the pump and heater, are under the pressure of the primary source of water supply.

THE MOST DIFFICULT PROBLEM in the development of the system was to devise some means for keeping the hot water from fusing the automatic sprinkler heads.

The first idea was to use sprinklers designed to operate at a high temperature, or what are known as "high test heads." The obvious objection from a fire protection standpoint caused this idea to be abandoned. Various methods were tried and there will probably be further improvements and refinements in this detail. It was found that placing the head at the end of a short branch pipe, instead of directly on the line, protected it from the heat. In the first installation this branch was made up (Fig. 1) by screwing a nipple into the tee in the line and putting an elbow into this and then with a 12-inch piece of pipe and another elbow bring the head at a little distance from the line pipe. The pipe was tilted at such an angle that some air would be entrapped in it next the heat. The idea was that air would act as an insulator.

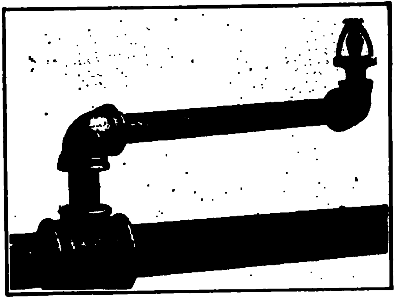


FIG. 1

In the later systems a bend (Fig. 2) is being used with success, the theory being that the water in the bend will not enter into the circulation and will remain cool. There have been many different types of bends evolved, and from the limited amount of experience with these systems it is difficult to determine just which is the best. Figs. 3 and 4 show two bends which have been used and accepted by the underwriters in some cases. In a general way either of these bends are satisfactory if so installed that the bottom of the bend itself is no lower than the bottom of the piping from which it branches. This arrangement gives enough insulation and does not provide a trap for sediment.

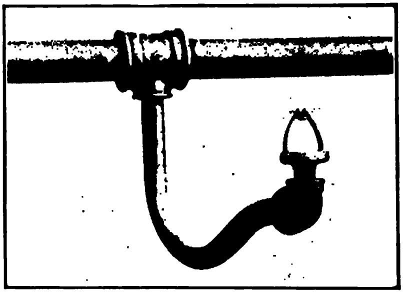


FIG. 2

THE GENERAL APPEARANCE

of this system is shown in one of the illustrations. In this equipment the horns have a simple bend, but the result is a rather clumsy appearing system of piping.

The principal advantage claimed for the combined system is economy in first cost. If there is enough radiating surface in the sprinkler system alone, of course this saving is quite important. If, however, any auxiliary heating apparatus has to be installed, the saving is decreased by just so much. This saving in first cost will vary widely, according to the peculiarities of the individual installations. It is sometimes estimated as high as 50 per cent. of the cost of the ordinary heating system. On the other hand, some installations show almost no saving at all.

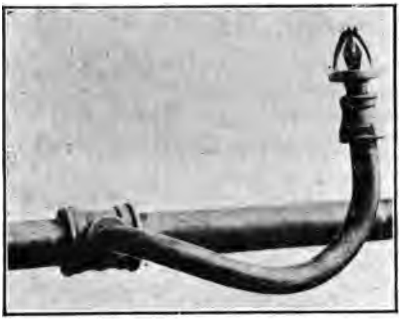


FIG. 3

It is also sometimes stated that this system can be used to advantage in unheated buildings on account of the objections to a dry system. As the defects in a modern dry system are more theoretical than practical, this advantage is not important.

THE PRINCIPAL OBJECTION TO THE SYSTEM

from an insurance standpoint is that the equipment is used for other than fire protection purposes and therefore cannot be so easily maintained constantly in service.

There are numerous valves, fittings and fixtures connected with this system which have to do with the heating feature. Adjustments, repairs and even renewals of them are required from time to time, making it necessary to interrupt the fire protection.

The deterioration of the whole system is much more than is the case with the usual sprinkler equipment, which is also an objection.

The possibility of sediment being carried into the short branches or into the heads themselves is also serious.

In designing a system of this sort, care should be taken that the valve arrangement be made as simple as possible. Usually it is possible to have but two valves to completely cut off the portion of the installation that has to do with heating alone.

THE ENTIRE SYSTEM SHOULD DRAIN

just as in an ordinary sprinkler equipment, as it must be remembered that on an average during one-half the year the system is in use as an ordinary wet system. It is better from a heating standpoint to reverse the usual practice and to pitch the lines toward the ends and away from the mains, but this is not as desirable from a fire protection standpoint. Alarm valves with the usual alarm gongs should be installed. Radiators and heating coils should not be connected into the sprinkler system. If they are necessary they should be supplied from a separate source of heat as if supplied from the same heater to have

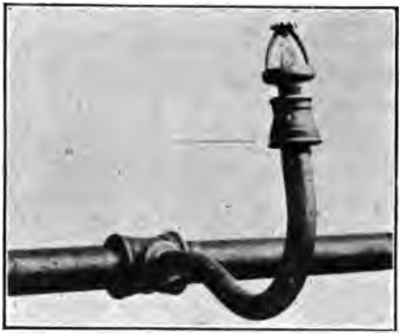


FIG. 4

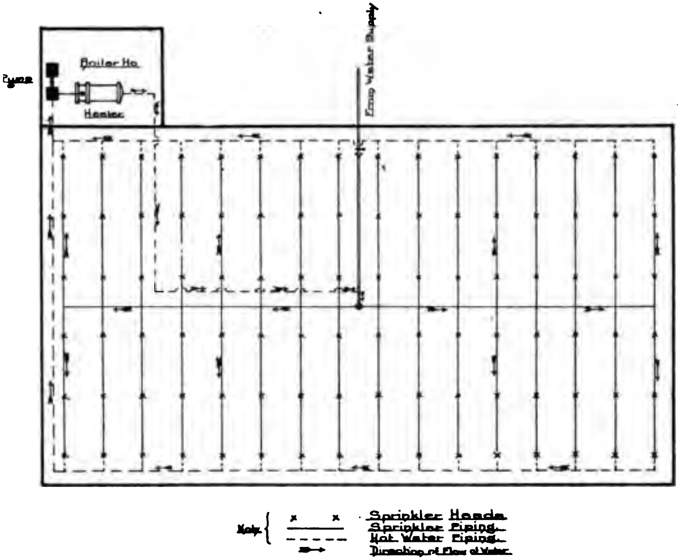
supply and return piped back to the heater direct.

There are many other details which have nothing to do with the sprinkler system feature which need not be mentioned here.

In considering these systems from a fire protection standpoint, or in designing them, it is well to bear in mind that the efficiency of the sprinkler system must never be made subservient to the use of the system for heating purposes.

THE EXPERIENCE WITH THESE EQUIPMENTS

is limited, and other advantages or defects may develop. With the information we have it would appear that from the standpoint of the property owner the objections rather overbalance the advantages. From an insurance standpoint there are no real advantages, and there are several very real objections to the arrangement.



DETAIL OF TYPICAL LAYOUT.

If accepted at all by underwriters, it certainly, in the present state of its development, ought not to receive the same credit as a plain sprinkler system designed in accordance with the usual specifications.

LIGHTNING RODS.

Remarks Upon the Efficiency of Lightning Rods and Pointers on Installation.

Bulletin of Ontario Department of Agriculture.

KIND OF RODS.

Material—Copper, aluminum or galvanized iron, preferably the first because of durability. Aluminum may prove equally durable. Combinations are not advised.

Weight—Copper—At least 3 ounces per foot. Aluminum—At least 2¼ ounces per foot. Steel (iron)—At least 4¼ ounces per foot.

Form—Any form that will give durability and convenience of installation.

GROUND CONNECTIONS.

Depth—Down to perpetual moisture. At least 8 feet deep.

Number—On an oblong building, at least two. On an L- or T-shaped building, at least three. On a U-shaped building, at least four.

Location—Preferably at opposite corners. Ground-rods should not be bunched, but should be distributed as well as possible.

Method—In deep soil drill a hole at least eight feet deep and run cable down. In shallow soil, attach cable to metallic ground-plate, down as deep as possible; or run it into a well or a stream or a crevice in the rock. If none of these are feasible, put cable as deep as possible and lay large, flat stone over it.

SYSTEMS.

Run cable from ground up corner to eave, thence to ridge, along ridge to other end, thence down to eave, thence to other ground, making a complete circuit.

All cables should be connected in one system.

No stubs or dead ends should be left ungrounded.

Caution—Cables should be protected from ground six or eight feet up by nailing boards around them.

ATTACHMENT.

Fasten cable to barn with nails, staples, clips or metal "dispersers."

Caution—Do not use insulators.

POINTS.

Number—20 to 30 feet apart.

Location—On ridge, first ones not over five feet from end. On or beside chimneys or cupolas. On dormers. Also on silos.

Height—Four to five feet, except those on or beside chimneys, cupolas or similar prominences; these must extend at least eighteen inches above the highest part.

Form—Strong tubes, of same weight and material as rods.

METALLIC PORTIONS OF STRUCTURE.

Roof-gutters—Top connected to rod, and bottom grounded.

Eave-troughs and Conductor-pipes—Free end of eave-troughs connected to rod. and conductor pipe grounded.

Hay-fork Track—Both ends connected to rod.

Tanks—Connected to rod above, grounded below.

Windmill—Connected to rod above, shaft grounded below.

Metallic Roof—Grounded at two or four corners, not from peak under any consideration.

Points should be used on the ridge and other prominences.

WIRE FENCES.

In field—A grounding at least every twenty rods.

In yards—At the four corners.

At building—Ground at first post from building.

Weight of Groundings—Equal to three No. 12 or one No. 9 wire.

How Made—Stapled on posts in contact with all wires of fence, and extending at least three feet in the ground, and projecting above fence.

Shade Trees—Protect where feasible.

VILLAGE AND TOWN FIRE PROTECTION.

Exposition on Water Supplies, Pumping Systems, and Fire Departments in Small Villages. Suggestions and Recommendations.

By Wm. S. Wensley, New York.

The protection of villages and small towns near New York City ranges from wells at the curb (in one case) with hand or gasoline engines to triple-expansion high-duty pumps of large capacity operated by steam. Between are duplex or triplex pumps run by steam or gasoline engines, or submerged centrifugal pumps actuated by electrical motors.

The smaller duplex pumps installed years ago may be found in condition varying from good, because recently overhauled, to poor, because there was none other of sufficient capacity, with the town's growing water consumption, to use while the pump could be repaired, or by reason of the indisposition of the water company to spend money for another pump.

Some pumps supply a standpipe or elevated tank near. These often do not contain enough water for the average daily consumption. Pumps at other stations fill horizontal water tanks, to which air tanks are connected with the air compressed so as to force the water into the mains. The static pressure, 45-55 pounds, is too light and the amount of water too limited for effective service in a fire of long duration, although by applying a weight to differential valves the pressure may be increased at once. These water tanks are often about 12,000 gallons apiece, and from four to six in a set. For a small community's domestic consumption they have the merit of low cost. If the wells and pumps are adequate and the latter can also be connected directly and quickly to the mains, one of the principal objections to this system is overcome.

Duplicate pumps are always necessary, even for a domestic consumption pumping system, so as to provide for the contingency of a delay at an inopportune time to replace a broken part. As boilers have to be cleaned each two weeks, they too need to be at least in pairs. The pumps and boilers are alternately used.

Some pumps are connected by friction clutch, spur gear and shaft, or directly by shaft to a driving engine. One plant has triple plunger pumps operated by gas engine first started by compressed air from a tank and then kept in motion by gas from a producer. The air compressor is run by electric motor, so that there are five different apparatus in the set. In other plants just before the gasoline engine running the pump is stopped it is connected to the air compressor, which fills the air tank to start the engine next time, a case of "you tickle me and then I'll tickle you."

Very few water company pumps are run by electric motor; they are likely to have current from only one source, which is occasionally shut off temporarily.

Pumps are generally at low levels near the wells or reservoirs, but the standpipes may be on some distant hill to get elevation for pressure. In a few cases compressed air forces the water from the wells up to the level of the pumps.

Wells vary greatly in number, size and depth. Their capacity is not necessarily proportioned to their size and depth except in a general way. A progressive water company in a growing community sinks more wells in advance of need.

An auxiliary well may have its water pumped to a receiving well, from which it is pumped directly to the mains or standpipe, etc.

Reservoirs fed by streams directly instead of by springs need filter beds very much, because of the silt and vegetable matter the streams empty into the reservoirs. When reservoirs follow the contour of the land, except at the artificial dam, to ascertain their capacity reliably reference has to be made to the engineer's early charts. In a case where the water supply of two systems was connected they were cleaning out the filter beds of both systems on the same day, so that the water supply of one was shut off and the other diminished at the same time.

Pump houses vary greatly from the basement of a small frame dwelling having street gas to run the pumps, which you pass by because there is no stack and no exhaust if the engine is idle at the time, to a handsome stone, tile roofed, nearly fireproof structure. Many are in basements of frame and shingle, shingle-roofed buildings, upper stories the engineer's dwelling, with boilers in freely communicating brick boiler houses. A fire starting at night when engineer would be asleep would burn the pump house to the ground before the arrival of the distant hose company in several cases. As a rule they have only small rubber hose, to wet down ashes, although one or two street hydrants are near and could reduce the loss materially and maybe prevent damage to the pumps if they only had fire hose. Still other pump houses are frame or brick, exclusively used as such or housing the town electric light plant with the hazards of the latter more or less—often less—safeguarded. The pump stations are generally on the outskirts of the town, where the land is cheaper. Boiler rooms as a rule are tidily kept. Passageways between boiler setting and building walls are sometimes used for miscellaneous storage without much increase in the hazard. Vents are usually safe, but an occasional one badly exposes woodwork. From a month to three months' supply of coal is kept on hand in sheds, often exposing the pump house, or in a coal chute near for the larger plants.

Engineers in smaller plants seem to understand their own apparatus fairly well, but are not of enough general intelligence to give as much information about it clearly as the insurance engineer wishes. In larger stations they add to one's knowledge. In a few small villages they collect the water bills or have outside duties and are absent from their engine room hours daily, first filling their tanks or standpipe in the morning and again late in the afternoon.

In the smaller plants, where economy is a desideratum all the time, it is well for the insurance engineer to see the steam and water gauges so soon as he gets to the station. The steam and water pressures are likely to be increased while he is making his general notes unless there is a water-pressure recording gauge. Static water pressures are generally many pounds lighter than they should be. It is not often in moderate weather that water companies will object to the taking of pressures and flowing quantities at hydrants. They often prefer to assist personally and will drive the insurance man in their motor car from point to point. Pressures are taken at low and high elevations, in the crowded mercantile section and near the end of a system on small mains in the residential district. Sometimes tests at two places only are necessary to cover these four points. A carriage driver will tell where the highest points in the town are, or these can be ascertained from a small U. S. topographical map. The first essential in a town inspection is to get a water map or blue print of sizes of mains and locations of hydrants. This helps to determine where water pressure tests should be made and can be used to note on it the locations of fire houses and fire-alarm boxes. Such map or blue print is usually furnished gratis through the generosity of the water company if they have a duplicate, or they will provide a table at which the insurance engineer can copy off the information from their single map, or they will lend their original drawing from which to have a blue print made. There is a fine vein in human nature, a philanthropic one, and it works voluntarily.

Arteries from pumps or standpipes to the gridiron system are sometimes single, instead of double and forming a loop. Now and then if they were larger they would be regarded with more complacency. Water companies seldom leave mains unprotected in beds of shallow streams or on bridges over rivers or railroad cuts. Mains in mercantile sections, where frequently there are frame rows, are often too small; and also in the distant residential portion with dead ends. This is the case even where the pressures are not all that is desired. It is not often that small pipes are between large laterals on other nearby streets.

In but few towns are the hydrants spaced not over two hundred and fifty feet apart in the mercantile district and five hundred near residences, as required by the standard. As hydrants are furnished according to the specifications of the buyer, they are of many types, even on one water system. They are generally alike in one respect, with 2½-inch outlets. They run the gamut of one-way, one-way and steamer connection, two-way, two-way and steamer connection, and four-way. More often they are hard to open than otherwise. The general claim is that they are oiled and flushed twice yearly. If that is so, then they should be four times yearly. They play all sorts of tricks on the man who opens them, and give him a free bath now and then and threaten him with pneumonia. They leak from any portion and more or less suddenly. While he is watching his wrench so it will not slip off and let him tumble backwards as he is pulling a stroke that would shame Harvard, the water unexpectedly squirts out of a joint and condemns his collar to the laundry or his suit of clothes to the "valet." Before the drip closes the water will bubble up through the gravel soil and over his feet.

The first remark to make about volunteer fire departments is that if their members are to be exempt from some of the obligations of other citizens, a high per centum of attendance at fires, say 85 per cent. of all fires, should be required of them, and the law should provide for their disqualification if they fell in any one year below that either through choice or disability, unless temporarily excused in advance. Without doubt there are members of fire companies whose best intention is to be exempt from other duties. The case is not so serious as it might be because the companies are generally well enough manned without the sometimes many delinquents. Officers are elected for one or two years by the members and sometimes have to be approved by the village trustees acting as fire commissioners. The New York State law requires that records be kept and a report be forwarded to Albany. As a rule good judgment is shown in locating the companies for quick response to different parts of a town.

The hand-drawn hose reel with from two hundred and fifty to five hundred feet of hose is still in use, but most often with it is a horse-drawn hose wagon with five hundred to about eight hundred feet of hose and a twenty-four foot extension ladder. Either a $5 reward is paid for the first team of horses responding, or passing autos or those of members haul the wagon, the latter at least gratis. Of steam fire engines there are a few in smaller towns, but they are seldom kept hot. In even sizeable villages the members have the auto fever and auto vehicles are taking the places of horse-drawn ones. In some of the communities they have had the good sense and enterprise to buy combination chemical tanks, hose and ladder wagons. Occasionally an auto-engine-driven pump is a valuable part of the combination. With about two hundred and fifty feet of chemical rubber hose this combination wagon is reducing the water as well as the fire damage. Most often the longest ladder on the hook and ladder truck will reach to the top of the tallest building in small towns.

Good cotton rubber-lined hose is the rule. Some departments have even better rubber hose. The quantity does not often fall far below the amount required. The couplings follow the New York City department sizes, but which are not National Standard.

Most of the fire houses are two story, frame, shingle roofed. The first floor is generally concrete, the second wood. Many have sheathed ceilings. They are not always so tidily kept as they should be. The second story is usually the meeting room, where suppers are given. One-story buildings in small villages often have a stage for entertainments or even motion-picture shows.

Because of the expense, few of the smaller towns have a fire alarm telegraph system, and in larger ones the boxes are far apart. The batteries, primary or storage, may be at police or fire department headquarters in non-fireproof buildings. Circuits are generally overhead. Supplementing the boxes are imaginary ones. There may be no box near John Smith's corner, but it is known as No. 236. If a neighbor 'phones headquarters that there is a fire, disc 236 is put on the instrument and the fire bell or siren repeats the number. The systems are tested once or twice daily from a different box.

Police! Again expense is a deterrent. We have to associate ourselves in large groups to afford all the "fixin's." Most of the smaller towns have to depend on the man with the ancient title. constable. The standard recognizes the situation and does not shout for police under thirty-five hundred inhabitants. Above that population many places do not have any police. Where there are any, most of them are on night duty.

Unincorporated villages have no fire limits, building codes or ordinances. Most of the smaller villages and small towns have only fragmentary provisions as to construction of buildings or ordinances regarding explosives and combustibles. Requirements are frequently left to the discretion of an officer, instead of being fixed. The fire insurance rules for outside storage of gasolene and for approved pumps are helping the situation materially.

In unincorporated villages the absent and distant State fire marshal seems to be the only man empowered to require the removal of dangerous accumulations of refuse.

Streets in these towns adjacent to New York City are as a rule macadamized or have better pavement. There are some stiff grades in hilly country where the elevations may vary one hundred feet. Most of the streets are under the minimum of seventy feet desired in the mercantile district.

High-tension currents occur here and there, but are most often under local control.

As is to be expected in these hard times, communities are growing slowly, but are prosperous, except that where a town has depended on wooden shipbuilding, its prosperity has come to a standstill.

Frame row and group fires, the latter due to rear sheds, are commonly possible. The prevalence of shingle roofs on dwellings throughout the town makes one wonder why there are not more small conflagrations. Collections of boxes, barrels and other rubbish back of grocery and other stores are inexcusable, but fortunately are not frequent. Accessibility to rears of buildings in mercantile sections is generally fairly good or better.

Towns and villages differ so in their equipment for defence against fires and there are so many items making up their protection and the rate that the insurance companies owe it to themselves and in fairness to the well-protected towns to base their rates on ascertained facts. A town may have an excellent equipment except in one vital respect, and only an inspection will bring the weak spot to light and charge for it and so assist in strengthening it. The water protection of the smaller towns and villages as a rule is considerably below standard. The reason for it probably is that the water equipment was supplied primarily for domestic purposes and only incidentally as a fire defence. The population being comparatively small, a big and expensive equipment was not warranted by the prospective profits to the water company. A town should pay for what it lacks in safety or protection and get credit for what it has spent its money for wisely. If it has paid as much for poor protection as another community has for good protection, it should get credit only for results and not for good intentions.

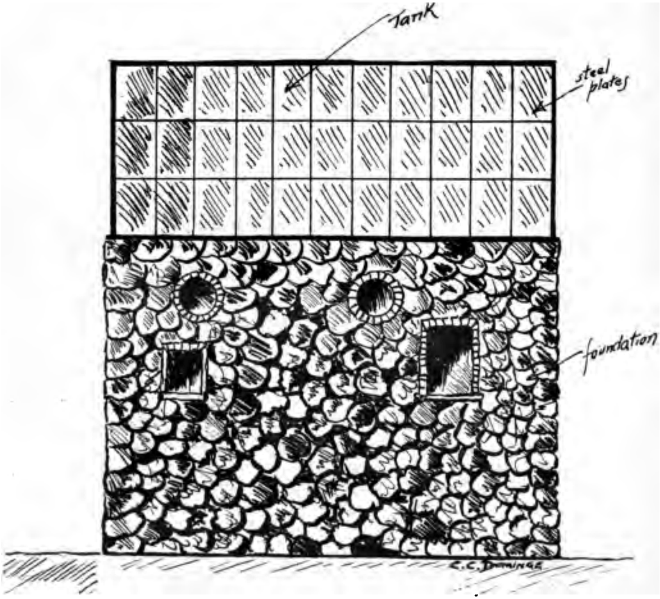
NEW YORK'S FIRST WATER WORKS.

By Charles C. Dominge, Insurance Engineer-Underwriter.

Within the past few days New York's first water works plant has become a memory.

Few people in passing the junction of Lafayette and Reade Streets realized that the old brick structure inclosing the large iron tank was once to New York City what the new Catskill water system is to-day.

In the year 1799 the Manhattan Water Company, now the Manhattan Bank, dug a well on the north side of Reade Street, near the corner of Lafayette Street. Just around the corner, at 2-4 Lafayette Street, they built a large circular stone structure, ap-



proximately forty-five feet in diameter, with walls about six feet thick. This formed the foundation for the water works, which consists of a cylindrical tank, approximately forty-two feet in diameter, and about fifteen feet high. The tank was made of cast-iron plates two feet wide and five feet long riveted together.

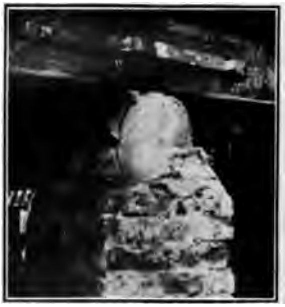
As is shown by the accompanying sketch the stone foundation resembled a fort having heavy stone arches and narrow apertures. It is said to have been called Fort Lafayette. It is possible that the foundation was designed to protect the water works in case of war or riot. The old upright engine and pump was visible in the sump pit during the razing of the building, although it had not been used in more than sixty years. A fact that would be interesting to insurance men is that the mortar used in the foundation walls was lined with a binder of wood shavings.

This antique water works, which has now been torn down to make room for progress, will doubtless be remembered by many of the earlier residents of the lower section of the city.

Fire Effect on Cap Stones.

The accompanying photograph by S. T. Skirrow, a well-known fire insurance inspector, affords a striking example of what fire and water will do to a cap stone on a brick pier. In cases where such piers support heavy loads the collapse of the floor or of the building is extremely likely in case of fire.

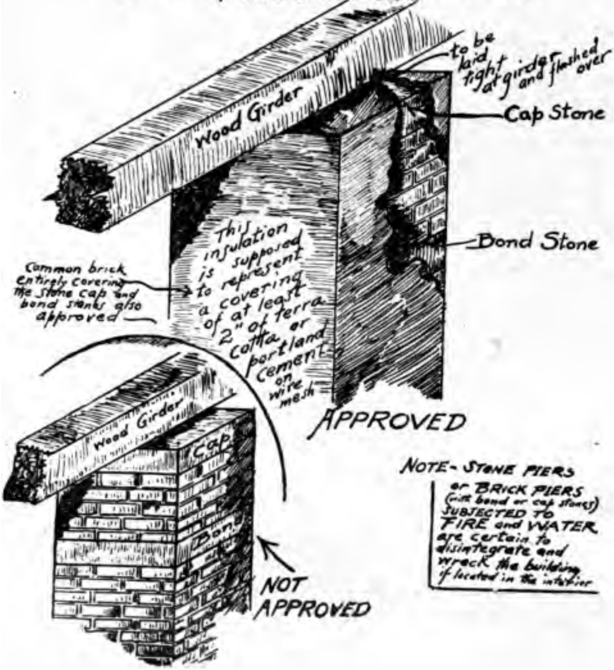
The requirements of the New York Fire Insurance Exchange covering such piers require that there be an insulation of not less than two inches of terra cotta or concrete to protect the bond and cap stones from disintegration and possible collapse, and in view of the conditions illustrated these requirements will be seen to be wise and necessary.



The accompanying sketch, by Charles C. Dominge, who originated the idea of illustrating correct conditions in this way for the benefit of the insured, shows graphically what is and what is not desirable in the way of pier construction.

STANDARDS FOR PIERS, PILLARS ETC.

IF STONE OR PART STONE


to be laid tight at girder and flushed over
Cap Stone
Wood Girder
Bond Stone
This insulation is supposed to represent a covering of at least 2" of terra cotta or portland cement on wire mesh
Common brick entirely covering the stone cap and bond stones also approved
APPROVED
Wood Girder
Cap
Bond
NOT APPROVED

NOTE - STONE PIERS or BRICK PIERS (with bond or cap stones) SUBJECTED TO FIRE and WATER are certain to disintegrate and wreck the building if located in the interior

STATIC ELECTRICITY.

From Automobile Topics.

While many skeptics refuse to accept the explanation that quite a number of garage fires are caused by "frictional," or static, electricity, caused by the operation of filling the tanks of cars, insurance authorities, and, in some instances, even the police are taking steps to guard against what they believe to be a very real source of danger. Among others the detective and fire inspection department of the city of Springfield, Mass., has made a study of conditions, which has resulted in several practical recommendations, which, fortunately, are simple and easily applied. The principle involved is merely that of ensuring good metallic connection between the original fuel container and the tank that is being filled, so that any electrical "charge" that may be produced will be grounded, all liability of the formation of a spark thus being prevented. In a statement published by the Automobile Club of Springfield, the department says:

"Recent fires in garages, caused by frictional electricity during the handling of gasoline, have prompted the department to institute exhaustive research to ascertain the true cause, and to devise a practical remedy therefor.

"Frictional or static electricity is more liable to be generated when the atmosphere is clear and dry than when it is moist. It is generated by the rubbing together of substances that in themselves are nonconductors of electricity, such as dry wood, rubber or gasoline; or it may be generated by friction between a nonconductor and a conductor, such as gasoline and a metal pipe, although in the latter the intensity is much diminished.

"In the drawing of gasoline from a pump into a metal can, no can should be used that has a wooden bail or handle in such a manner that the wood will intervene between the metal of the can and that of the pump on which it is hung.

"In filling the tank of a motor vehicle with gasoline from a metal can, care should be taken that good metallic connection exists, not only between the tank and other metallic parts of the vehicle, but between the funnel and the tank as well. The pouring can should have a piece of copper chain soldered to the nozzle, the other end to rest in metallic connection with the tank or the funnel during filling.

"Motor vehicles that are filled by means of a hose direct from a storage tank or a portable tank should have hose with a continuous metallic lining which is in good metallic connection with the pump at one end and the shut-off nozzle at the other end, or with bare copper wire inside of the hose, with like connections at both ends.

"Shut-off nozzles at the end of hose lines should be fitted with copper chain to rest on the car tank in metallic connection during filling, or with a metal clamp serving the same purpose.

"The passage of gasoline through a chamois skin strainer has been found to generate electricity which is collected in the metal parts of the funnel in dangerous intensity, and the substitution of a funnel with a strainer of 80 or 90 mesh wire which will exclude water is recommended.

"Safety lies in maintaining good metallic connection between the storage tank and the tank of the motor vehicle during the process of filling, so that all electricity generated may readily pass off to the ground as fast as generated."

The Fireproofing of Cotton Goods.

By J. E. Tod, Manchester, Eng.

The cost of fireproofing flannelette by the non-flam process, as regards work done in this country, has been greatly exaggerated.

The cost of chemicals—sodium stannate and ammonium sulphate—as the goods have been run commercially by us—has varied from one-quarter penny to one-half penny per yard, the lower price being for flannelettes of lower quality, 32 inches wide, and the higher price for good quality, 36 inches wide. The cost of labor has been the same in all cases, one-quarter penny per yard.

To these prices we ourselves added one-eighth penny per yard for royalties, experimental and research work, etc. The total additional cost for the fireproofing process was thus from five-eighths of a penny to seven-eighths of a penny per yard.

You will notice we have referred to this process in the above statement somewhat in the past tense. As a matter of fact, we are still fireproofing by this process, but are expecting shortly to change to another and much better one.

You will be interested to hear that Professor Perkin and his assistants, continuing their researches, have discovered a new process for permanently fireproofing cotton materials. In this case the cost of the chemicals is not more than one-half and maybe as low as one-quarter of the older process.

The cost of labor will not be higher. In fact, we are confident it will be considerably lower.

Machinery is now being erected to work this process on the commercial scale.

About twelve months ago we threw open the process described in Professor Perkin's lecture at the meeting of the National Association of Cotton Manufacturers at Atlantic City, September, 1913, so the cost is reduced by the amount of the royalties—one-eighth penny per yard.

INDEX OF ARTICLES ON FACTORY INSPECTION TO BE FOUND IN THE FIRST FIVE VOLUMES OF LIVE ARTICLES ON SPECIAL HAZARDS

	VOL.	PAGE
Apple Evaporators	6	75
Artificial Flowers and Feathers	5	104
Asbestos	6	106
Asphalt Plants	6	31
Blind Attics	5	33
Breweries	1	60
Breweries	5	5
Breweries	6	91
Brickyards	1	36
Button Factories	5	21
Cabinet Factories	2	55
Candy Factories	1	48
Celluloid Manufacture	3	74
Celluloid Manufacture	4	97
Celluloid Manufacture	6	83, 89
Cleaning and Dyeing Risks	6	97
Clothing Factories	1	14
Concrete	6	70
Cork Factories	5	66
Cork Factories	6	107
Cotton Mills	1	5
Cooperage Industry	4	82
Crude Oil and Oil Refineries	6	5
Dry Goods Stores	4	135
Electrical Hazards	4	102
Embroidery Works	5	45
Enameled Leather Manufacture	1	42
Fireproof Buildings	2	65
Flour Mills	2	34
Garages and Automobiles	2	61
Garages and Automobiles	3	80
Garages	6	104
Gasolene, Naphtha and Benzine	6	14
Gas Works	5	116
Gas Works (Oxygen)	6	100
Hat Factories	2	93
Hotels	2	84
Illuminating Gas	5	116
Iron Galvanizing Plants	4	98
Laundries	3	87
Leather Manufacture	1	42
Leather Manufacture	3	5
Leather Manufacture	5	57
Lightning Rods	6	121

INDEX OF ARTICLES—Continued

	VOL.	PA
Liquor Risks	1	
Liquor Risks	5	
Metal Workers	1	
Metal Workers	4	
Motion Picture Theaters	6	
Oils, Paints, Etc	1	
Oils, Paints, Etc	3	
Oils, Paints, Etc	4	17, 41,
Oils, Paints, Etc	5	
Oils, Paints, Etc	6	5, 14,
Oxygen Tanks	6	
Paint and Varnish Works (See Oils, Paints, Etc.)		
Paper Box Factories	4	
Paper Mills	2	
Paper Storage	4	
Plans, How to Read, etc	5	
Printing and Allied Trades	2	
Refrigeration	5	
Rubber Manufacture	3	
Rubber Manufacture	4	
Shingle Mills	4	
Shoe Factories	3	
Shoe Factories	6	
Soap Factories	1	
Sprinkler Efficiency	4	
Sprinklers and Heating Systems	6	
Static Electricity	6	
Storage Warehouses	1	
Sugar Refineries	2	
Tanneries	3	
Theaters	1	
Tobacco Manufacture	1	
Tobacco Manufacture	2	
Toy Factories	4	
Varnish Works (See Oils, Paints, etc.).		
Woodworkers	2	
Woodworkers	3	
Woodworkers	3	
Woodworkers	4	56, 71,
Woolen Mills	4	
Forms, From the Broker's Standpoint	3	
Forms, From the Company's Standpoint	3	
Insurance Engineer, The	6	
Organization of an Insurance Company	3	
Use and Occupancy Insurance	4	159,
Village and Town Fire Protection	6	

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